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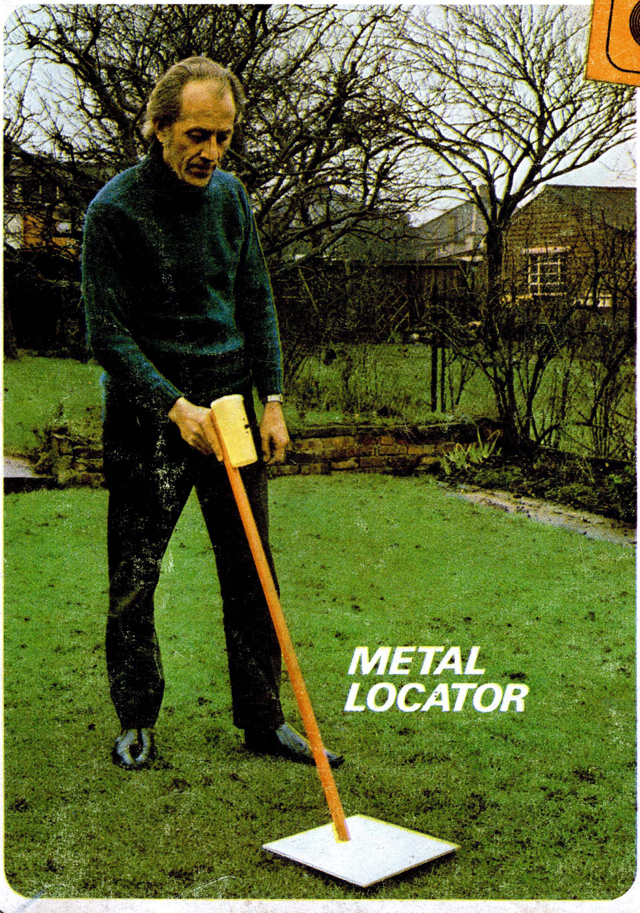
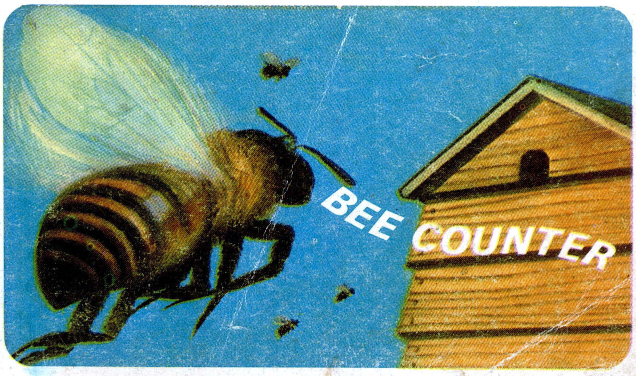
133

CONSTRUCTORS COMPANION





The Specification sounds fine the System sounds great

Viscount III Audio Suite complete £49

14 + 14W per channel 40Hz to 40kHz ± 3dB Total distortion at 10 watts at 1kHz —0·1%.

This is real value for money! We have designed 3 systems and the heart of them all is the Viscount III amplifier. A unit of great eye appeal with teak finished cabinet. It is available in 2 versions — R100 for ceramic cartridges, and R101 for magnetic and ceramic. FET's (Field effect transistors) are incorporated on the input stages, just like top priced units. FET's give you more of the signal you want and almost none of the hiss you don't. Both units have output sockets for headphones and tape recorder. Filters and tone controls give a wide range of bass and treble adjustment.

For all systems we have chosen the famous Garrard SP25 Mk. III deck which comes complete with teak finished plinth and perspex cover.

The exclusive Duo loudspeaker systems are incomparable for quality within their price range. Large speakers in extremely substantial cabinets. There's a choice of the Duo II's for the smaller room or the big Duo III's for real bass response.

PRICES

SYSTEM 1

Viscount III R101 amplifier	£22·00+90p p&p
2 x Duo Type II speakers	£14·00+£2 p&p
Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23·00+£1·50 p&p
Total	£59·00

Available complete for only £52+£3·50 p&p

SYSTEM 2

Viscount R101 amplifier	£22·00+90p p&p
2 x Duo Type III speakers	£32·00+£3 p&p
Garrard SP25 Mk. III with MAG. cartridge, plinth and cover	£23·00+£1·50 p&p
Total	£77·00

Available complete for only £69+£4 p&p

SYSTEM 3

Viscount III Amplifier R100	£17·00+90p p&p
2 x Duo Type II speakers, pair	£14·00+£2 p&p
Garrard SP25 Mk. III with CER. diamond cartridge, plinth and cover	£21·00+£1·50 p&p
Total	£52·00

Available complete for only £49+£3·50 p&p

SPEAKERS Duo Type II

Size approx. 17" x 10¾" x 6¾". Drive unit 13" x 8" with parasitic tweeter. Max. power 10 watts, 3 ohms. Simulated Teak cabinet. **£14 pair**+£2 p&p.

Duo Type III. Size approx. 23½" x 11½" x 9½". Drive unit 13½" x 8¼" with H.F. speaker. Max. power 20 watts at 3 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. **£32 pair**+£3 p&p.

SPECIFICATION R101

14 watts per channel into 3 to 4 ohms. Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within ±1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to −17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to −12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max) R101—P.U.1 and radio—65dB. P.U.2 —58dB. **R100** same as R101 but P.U.2 (for crystal cartridges) 450mV into 3 Meg. *Cross talk* better than −35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size approx 13¾" x 9" x 3¾".

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Garrard SL72B	£24·00
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Cambridge P40	£65·95
Cambridge P50	£71·00
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Ferrograph F307 Mk. II (Metal cased)	£45·00
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Leak Delta 70	£56·00
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Pioneer SA900	£92·00
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Rogers R/brook (Cased)	£37·00
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Armstrong 524	£31·00
Rogers Ravensbrook FET4 (Chassis)	£31·00
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Rogers Ravenbourne FET4 (Chassis)	£43·00
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Please add £1·25 P. & P. per pair

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Wharfedale Melton 2	£47·95
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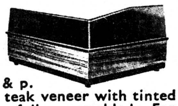

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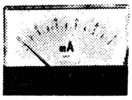
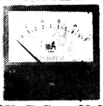


TYPE SW.100
100 x 80 mm.

		20V. D.C.	£3·10
50µA	£3·60	50V. D.C.	£3·10
50–0–50µA	£3·45	300V. D.C.	£3·10
100µA	£3·20	1 amp. D.C.	£3·10
100–0–100µA	£3·45	5 amp. D.C.	£3·10
500µA	£3·35	300V. A.C.	£3·10
1mA	£3·10	VU Meter	£3·75

BAKELITE PANEL METERS

TYPE S-80
80 mm.
square fronts



50µA	£3·20		
50–0–50µA	£3·10	50V. D.C.	£2·60
100µA	£2·75	300V. D.C.	£2·60
100–0–100µA	£3·10	1 amp. D.C.	£2·60
500µA	£3·00	5 amp. D.C.	£2·60
1mA	£2·60	300V. A.C.	£2·60
20V. D.C.	£2·60	VU Meter	£3·37

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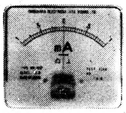
Type MR.85P. 4¼in. × 4¼in. fronts.



		50mA	£2·80
		100mA	£2·80
		500mA	£2·80
		1 amp.	£2·80
		5 amp.	£2·80
		15 amp.	£2·80
		30 amp.	£2·90
		20V. D.C.	£2·80
		50V. D.C.	£2·80
50µA	£3·60	150V. D.C.	£2·80
50–0–50µA	£3·10	300V. D.C.	£2·80
100µA	£3·10	15V. A.C.	£2·80
100–0–100µA	£3·00	300V. A.C.	£2·80
200µA	£3·00	S Meter 1mA	£2·87
500µA	£2·90	VU Meter	£3·60
500–0–500µA	£2·80	1 amp. A.C.*	£2·80
1mA	£2·80	5 amp. A.C.*	£2·80
1–0–1mA	£2·80	10 amp. A.C.*	£2·80
5mA	£2·80	20 amp. A.C.*	£2·80
10mA	£2·80	30 amp. A.C.*	£2·80

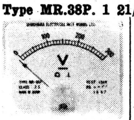
Type MR.52P. 2⅜in. square fronts.

50µA	£3·10	10V. D.C.	£2·00
50–0–50µA	£2·60	20V. D.C.	£2·00
100µA	£2·60	50V. D.C.	£2·00
100–0–100µA	£2·50	300V. D.C.	£2·00
500µA	£2·30	15V. A.C.	£2·10
1mA	£2·00	300V. A.C.	£2·10
5mA	£2·00	S Meter 1mA	£2·10
10mA	£2·00	VU Meter	£3·20
50mA	£2·00	1 amp. A.C.*	£2·00
100mA	£2·00	5 amp. A.C.*	£2·00
500mA	£2·00	10 amp. A.C.*	£2·00
1 amp.	£2·00	20 amp. A.C.*	£2·00
5 amp.	£2·00	30 amp. A.C.*	£2·00

Type MR.65P. 3⅜in. × 3⅛in. fronts.

50µA	£3·37	10V. D.C.	£2·20
50–0–50µA	£2·75	20V. D.C.	£2·20
100µA	£2·75	50V. D.C.	£2·20
100–0–100µA	£2·65	150V. D.C.	£2·20
200µA	£2·65	300V. D.C.	£2·20
500µA	£2·40	15V. A.C.	£2·30
500–0–500µA	£2·20	50V. A.C.	£2·30
1mA	£2·20	150V. A.C.	£2·30
5mA	£2·20	300V. A.C.	£2·30
10mA	£2·20	500V. A.C.	£2·30
50mA	£2·20	S Meter 1mA	£2·37
100mA	£2·20	VU Meter	£3·37
500mA	£2·20	50mA A.C.*	£2·20
1 amp.	£2·20	100mA A.C.*	£2·20
5 amp.	£2·20	200mA A.C.*	£2·20
10 amp.	£2·20	500mA A.C.*	£2·20
15 amp.	£2·20	1 amp. A.C.*	£2·20
20 amp.	£2·20	5 amp. A.C.*	£2·20
30 amp.	£2·30	10 amp. A.C.*	£2·20
50 amp.	£2·50	20 amp. A.C.*	£2·20
5V. D.C.	£2·20	30 amp. A.C.*	£2·20

Type MR.38P. 1 21/32in. square fronts.



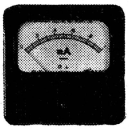
		200mA	£1·60
		300mA	£1·60
		500mA	£1·60
		750mA	£1·60
		1 amp.	£1·60
		2 amp.	£1·60
		5 amp.	£1·60
		10 amp.	£1·60
50µA	£2·10	3V. D.C.	£1·60
50–0–50µA	£1·90	10V. D.C.	£1·60
100µA	£1·90	15V. D.C.	£1·60
100–0–100µA	£1·75	20V. D.C.	£1·60
200µA	£1·75	100V. D.C.	£1·60
500µA	£1·65	150V. D.C.	£1·60
500–0–500µA	£1·60	300V. D.C.	£1·60
1mA	£1·60	500V. D.C.	£1·60
1–0–1mA	£1·60	750V. D.C.	£1·60
2mA	£1·60	15V. A.C.	£1·70
5mA	£1·60	50V. A.C.	£1·70
10mA	£1·60	150V. A.C.	£1·70
20mA	£1·60	300V. A.C.	£1·70
50mA	£1·60	500V. A.C.	£1·70
100mA	£1·60	S Meter 1mA	£1·70
150mA	£1·60	VU Meter	£2.10

Type MR.45P. 2in. square fronts.

50µA	£2·25	5 amp.	£1·70
50–0–50µA	£2·10	10V. D.C.	£1·50
100µA	£2·10	20V. D.C.	£1·50
100–0–100µA	£1.87	50V. D.C.	£1·50
200µA	£1·87	300V. D.C.	£1·50
500µA	£1·75	15V. A.C.	£1·80
500–0–500µA	£1·70	300V. A.C.	£1·80
1mA	£1·70	S Meter 1mA	£1·85
5mA	£1·70	VU Meter	£2·25
10mA	£1·70	1 amp. A.C.*	£1·70
50mA	£1·70	5 amp. A.C.*	£1·70
100mA	£1·70	10 amp. A.C.*	£1·70
500mA	£1·70	20 amp. A.C.*	£1·70
1 amp	£1·70	30 amp. A.C.*	£1·70

"SEW" BAKELITE PANEL METERS

Type MR.65. 3⅛in. square fronts.

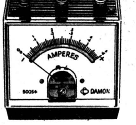


		1 amp.	£1·95
		2 amp.	£1·95
		5 amp.	£1·95
		15 amp.	£1·95
		30 amp.	£1·95
		50 amp.	£1·95
		5V. D.C.	£1·95
		10V. D.C.	£1·95
		20V. D.C.	£1·95
		50V. D.C.	£1·95
		150V. D.C.	£1·95
25µA	£3·50	300V. D.C.	£1·95
50µA	£2·75	30V. A.C.*	£1·95
50–0–50µA	£2·35	50V. A.C.*	£1·95
100µA	£2·35	150V. A.C.*	£1·95
100–0–100µA	£2·25	300V. A.C.*	£1·95
500µA	£2·20	500mA A.C.*	£1·95
1mA	£1·95	1 amp. A.C.*	£1·95
1–0–1mA	£1·95	5 amp. A.C.*	£1·95
5mA	£1·95	10 amp. A.C.*	£1·95
10mA	£1·95	20 amp. A.C.*	£1·95
50mA	£1·95	30 amp. A.C.*	£1·95
100mA	£1·95	50 amp. A.C.*	£1·95
500mA	£1·95	VU Meter	£3·10

*MOVING IRON—ALL OTHERS MOVING COIL

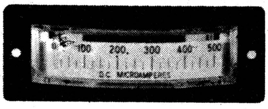
Please add postage

SEW EDUCATIONAL METERS



Type ED.107. Size overall 100mm × 90mm × 108mm. A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3″ mirror scale. The meter movement is easily accessible to demonstrate internal working. Available in the following ranges:

50µA	£5·00	20V d.c.	£4·40
100µA	£4·65	50V d.c.	£4·40
1mA	£4·40	300V d.c.	£4·40
50-0-50µA	£4·65		
1-0-1mA	£4·40	Dual range	
1A d.c.	£4·40	500mA/5A d.c.	£4·65
5A d.c.	£4·40	5V/50V d.c.	£4·65
10V d.c.	£4·40		



EDGEWISE METERS

Type PE.70. 3 17/32in. × 1 15/32in. × 2½ in. deep.

50µA	£3·10	500µA	£2·75
50–0–50µA	£3·00	1mA	£2·45
100µA	£3·00	300V. A.C.	£2·45
100–0–100µA	£2·90	VU Meter	£3·40
200µA	£2·90		

Send for illustrated brochure on SEW Panel Meters—discounts for quantities.

MULTIMETERS for EVERY purpose!

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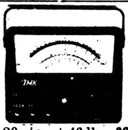

MODEL PL436 20kΩ/Volt D.C. 8kΩ/Volt A.C. Mirror scale. ·6/3/12/30/120/600V D.C. 3/30/120/600V A.C. 50/600uA/60/600 mA. 10/100K/1 Meg/10 MegΩ, −20 to +46db. **£6·97½.** P. & P. 12½p.

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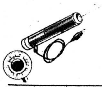
HIOKI MODEL 700X 100,000 O.P.V. Overload protection. Mirror scale. ·3/·6/1·2/1·5/3/6/12/30/60/120/300/600/1200VDC 1·5/3/6/12/30/60/150/300/600/1200 V. A.C. 15/30µA/3/6/30/60/150/300 mA 6/12 AMP. DC. 2K/200K/2 Meg/20 Meg ohm −20 to +63 db **£13·50.** P. & P. 20p.

ROUND SCALE TYPE PENCIL TESTER MODEL TS.68



Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V AC and DC at 2,000 o.p.v. Resistance 0-20K ohms. ONLY **£1·97** P. & P. 13p

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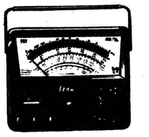

Battery operated, 11 meg input, 26 ranges. Large 4⅜″ mirror scale. Size 5⅞″ x 4⅝″ x 2⅜″. DC VOLTS 0 3 - 1200V. AC VOLTS 3 - 300V RMS. 8·0 - 800V P-P. DC CURRENT ·12 - 12MA. Resistance up to 2000M ohm. Decibels - 20 to + 51 db Complete with leads/instructions. **£17.50,** P. & P. 20p.

TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 Kc/s–500 Mc/s on 6 bands. Directly calibrated Variable R.F attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions. **£15.** Carr. 37½p. Size 140 × 215 × 170 mm.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

Sine: 20cps to 200 kc/s on 4 bands. Square: 20cps to 30 kc/s. Output impedance 5,000 ohms, 200/250V. A.C. operation. Supplied brand new and guaranteed with instruction manual and leads. **£17·50.** Carr. 37½p.

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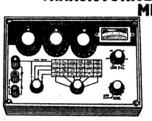

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 megΩ 6 Ranges ±1% L.1 µ H - 111 HENRYS 6 Ranges2 = %C.10pF±1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100µA. Meter indication. Attractive 2 tone metal case. Size 7¾ × 5 × 2in. **£20.** P. & P. 25p

MODEL TE-300. 30,000 O.P.V. Mirror scale, overload protection 0/·6/3/15/60/300/1,200V. D.C. 0/6/30/120/600/1,200V. A.C. 0/30uA/6mA/60mA/300mA/600mA. 0/8K/80K/800K/8 meg. ohm −20 to +63 db. **£5·97½.** P. & P. 15p.

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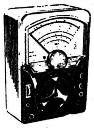
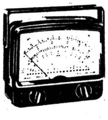
TMK MODEL MD.120 Mirror scale. 20k/Volt D.C. 10kΩ Volt A.C. 30/60/300/600/3,000 V. D.C. 6/120/1,200 V. A.C. Current 0–60uA/0 — 12/0 300mA. 0-60K/0-6 MegΩ. =20 to +63 dB. **£4·62½.** P. & P. 15p.



MODEL 500 30,000 O.P.V. with overload protection mirror scale 0/·5/2·5/10/25/100/250/500/1,000 V. D.C. 0/2·5/10/25/100/250/500/1,000V. A.C. 0/50µA/5/50/500mA. 12 amp. D.C 0/60/K/6 Meg./60 MegΩ. **£8·87½.** Post paid.



TMK LAB TESTER. 100,000 O.P.V. 6½in. Scale Buzzer Short Circuit Check. Sensitivity: 100,000 O.P.V. D.C. 5K/Volt A.C. D.C. Volts: ·5, 2·5, 10, 50, 250, 1,000 V. A.C. Volts: 3, 10, 50, 50, 250, 500, 1,000V. D.C. Current: 10, 100µA, 10, 100, 500mA, 2·5, 10 amp. Resistance: 1K, 10K, 100K, 10MEG, 100MEGΩ. Decibels: −10 to +49 db. Plastic Case with Carrying Handle. Size: 7½in. × 6¾in. × 3⅞in. **£18·90.** P. & P. 25p

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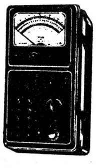
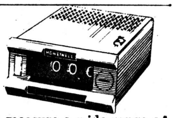
RUSSIAN 22 RANGE MULTIMETER



Model U437 10,000 o.p.v. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5/10/50/250/500/1000v D.C. 2·5/10/50/250/500/1000v A.C. DC Current 100 wA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3MΩ. Complete with batteries, test leads, instructions and sturdy steel carrying case. OUR PRICE **£5·97** P. & P. 25p.

HONEYWELL DIGITAL VOLTMETER VT.100



Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt, current and ohms with optional plug in cards. Specification: Accuracy: ± 0·2, ± 1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power: 110-230v. A.C. 50/60 cycles. Overall size: 5⅝in. x 2 13/16in. x 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED AT APPROX. HALF PRICE. **£49·97½.** Carr. 50p.

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2N697	15p
2N698	25p
2N699	30p
2N706	10p
2N706A	12p
2N708	15p
2N709	62p
2N718	25p
2N718A	30p
2N726	30p
2N727	30p
2N914	17p
2N916	17p
2N918	30p
2N929	22p
2N930	20p
2N987	40p
2N1090	22p
2N1091	22p
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2N1132	25p
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2N1637	30p
2N1638	27p
2N1639	27p
2N1701	162p
2N1711	24p
2N1889	32p
2N1893	37p
2N2147	72p
2N2160	57p
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2N2222	20p
2N2222A	25p
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2N2540	22p
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2N3402	22p
2N3403	22p
2N3404	32p
2N3405	45p
2N3414	22p

2N3415	22p
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2N3566	22p
2N3568	25p
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2N3716	130p
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2N3791	206p
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2N4062	12p
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2N4248	15p
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2N4254	42p
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2N4285	17p
2N4286	17p
2N4287	17p
2N4288	15p
2N4289	17p
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2N4292	15p
2N4294	17p
2N4303	47p
2N4964	15p
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2N5027	52p
2N5028	57p
2N5029	47p
2N5030	42p
2N5172	12p
2N5174	52p
2N5175	52p
2N5176	45p
2N5232A	30p
2N5245	45p
2N5246	42p
2N5249	67p
2N5265	325p
2N5305	37p
2N5306	40p
2N5307	37p
2N5308	37p
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2N5310	42p
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2N5367	57p
2N5457	30p

2N5458	35p
2N5459	40p
2S102	25p
2S103	25p
2S104	25p
2S301	50p
2S302	50p
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40311	35p
40312	47p
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40407	40p
40408	52p
40409	55p
40410	62p
40412	50p
40467A	57p
40468A	35p
40528	72p
40600	57p
40603	50p
AC107	30p
AC126	20p
AC127	24p
AC128	20p
AC151	18p
AC152	22p
AC154	22p
AC176	20p
AC187	25p
AC188	25p
ACY17	27p
ACY18	24p
ACY19	24p
ACY20	20p
ACY21	20p
ACY22	10p
ACY28	17p
ACY39	47p
ACY40	20p
ACY41	15p
ACY44	25p
AD140	47p
AD149	47p
AD150	62p
AD161	35p
AD162	35p
AF109	45p
AF114	25p
AF115	25p
AF116	25p
AF117	20p
AF118	60p
AF121	30p
AF124	22p
AF125	19p
AF126	19p
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everyday electronics

PROJECTS..
THEORY.....

FOR ALL SEASONS

Our cover this month has quite an outdoor touch. Of course, you don't have to be an apiarist to sense that things are beginning to buzz in the outside world. Spring is now well advanced and thoughts are likely to be turning towards all kinds of pastimes and occupations for the coming summer months.

It is an appropriate time to point out that do-it-yourself electronics has no closed season. Outdoor activities like gardening, touring, camping, sporting events, and so on, present many unique opportunities for putting electronics to effective use. So we advise, take stock *now,* anticipate your needs and start building to remedy any deficiencies in this respect.

GOOD COMPANION

The *Constructors Companion* given free with every copy of this month's EVERYDAY ELECTRONICS is small and compact. It has been designed for your pocket, so that wherever you go you can have essential facts constantly at hand. Compiled with the beginner particularly in mind, this booklet will prove a valuable *aide-memoire* for the more experienced constructor as well.

Those still feeling their feet will be glad of the technical back-up they can instantly call upon when confronted with a choice of allegedly alternative or equivalent parts when shopping personally for components.

READY ACCESS

Our regular readers will already appreciate the amount of important and useful information they are accumulating, as the months go by. True, not everyone will have an immediate need for every project described. But a word of advice: do not discard back numbers. You never know when circumstances may arise that create a definite need which some previously described project would satisfy exactly.

This leads us on to another common problem: how to store numerous copies of a magazine so that ready access may be made at any time to one particular article. The only really satisfactory solution is to keep copies of the magazine in the binder specially designed to hold 12 issues of EVERYDAY ELECTRONICS and which is now available.

Fred Bennett.

Our June issue will be published on Friday, May 19

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VOL. I NO. 7 MAY 1972

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

Audio Tone Generator

BY FRED JUDD

This simple tone generator covers the audio range from 50 to 2,000 Hz and has been specifically designed for use with a tape recorder to make electronic music.

THE multivibrator is one of the most commonly used electronic oscillator circuits and generates an almost square waveform. It can be made to cover a wide frequency range without the need for switching in different values of components and moreover will produce a high output signal level for a relatively small supply voltage. As a primary signal generator it has many uses as a test instrument in audio as well as electronic applications.

The generator described in this article is used as a tone source for the creation of electronic music and "science fiction" sound effects in conjunction with a tape recorder. The feature *Electronic Sounds and Music* on page 363 deals with the use of the tone generator in detail.

GENERATOR CIRCUIT

The circuit diagram is given in Fig. 1 and employs three *pnp* transistors, two of which form the multivibrator (TR1 and TR2), the remaining one, TR3, being used as a squaring amplifier.

The operating frequency and mark to space ratio (see Fig. 2) of the multivibrator are set by the time taken for C2 and C3 to charge up enough to switch transistors TR2 and TR1 respectively. This "charging time" is determined by the value of the capacitor and the value of the resistor through which it is charged.

Providing the time taken for each capacitor to charge is similar then the mark to space

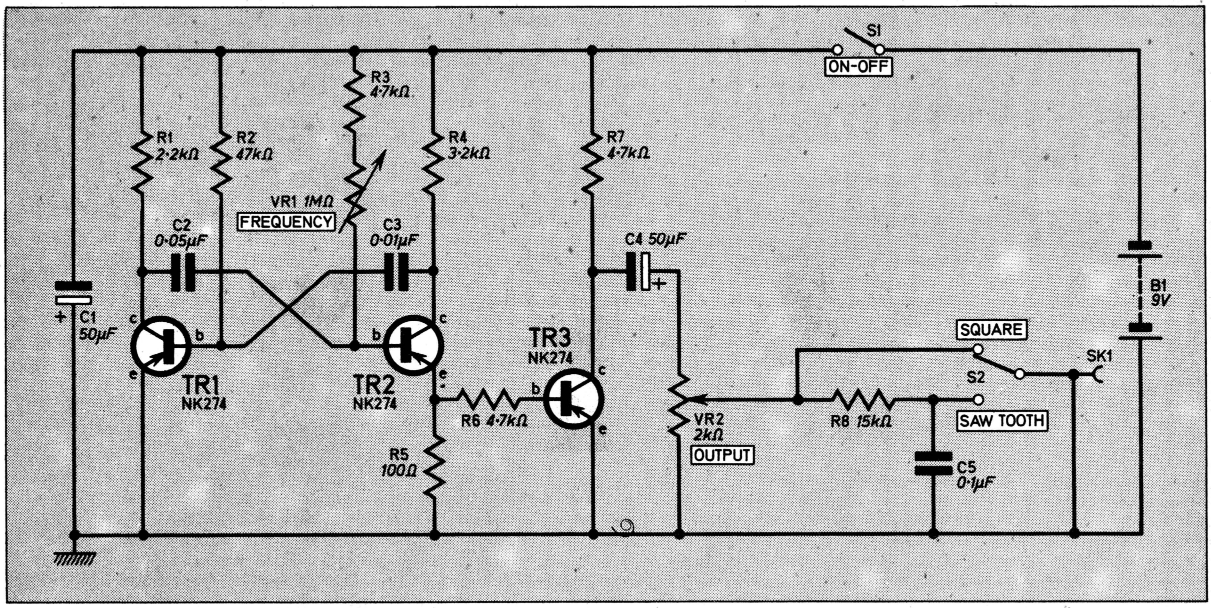


Fig. 1. Complete circuit diagram of the Audio Tone Generator.

ratio will be 1 to 1 or the mark and space will be of similar duration (Fig. 2). If we now change one of the controlling values—in this case VR1—both the frequency and mark to space ratio will be altered.

If we increase the value of VR1 the frequency will decrease as C2 will take longer to charge, and the mark to space ratio will alter for the same reason (see Fig. 3). Thus frequency control is achieved by VR2 and the total frequency range is approximately 50 to 2,000Hz.

The waveform has a mark to space ratio of 1 to 1 at approximately 1,500Hz at all lower frequencies the mark to space ratio increases becoming about 1 to 20 at the lowest frequency (Fig. 3).

The output from the multivibrator is taken from the emitter of TR2, through R6 to the base of TR3. Transistor TR3 is switched hard on and off by the output from TR2 and thus ensures a completely square output at its collector. The output level from TR3 is continuously variable from O to approximately 7 volts by VR2.

SAWTOOTH OUTPUT

The square wave output from TR3 can also be switched via S2 through an integrating network, C5 and R8, to provide an approximately sawtooth waveform (Fig. 4) of about 1 volt peak-to-peak maximum output, instead of the square-wave.

One of the major differences between a square wave and a sawtooth wave is the harmonic content and hence the tonal quality, when either are made audible via an amplifier and loudspeaker. The square wave contains only odd harmonics, in addition to its fundamental, whereas a sawtooth wave consists of both odd and even harmonics plus the fundamental.

Audibly the square wave has a sound rather like that produced by a clarinet particularly in the region of middle C (261Hz approx.). The sawtooth wave has a sound rather more like a

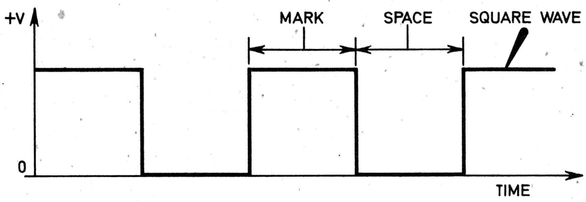


Fig. 2. A square wave with a 1 to 1 mark to space ratio.

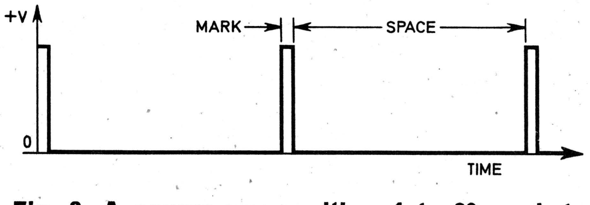


Fig. 3. A square wave with a 1 to 20 mark to space ratio.

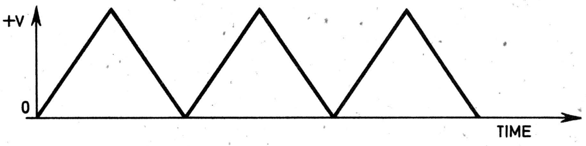
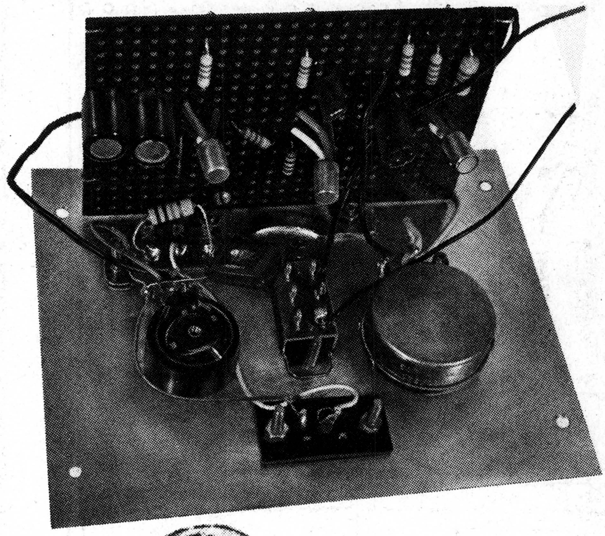


Fig. 4. A sawtooth waveform.

Audio Tone Generator



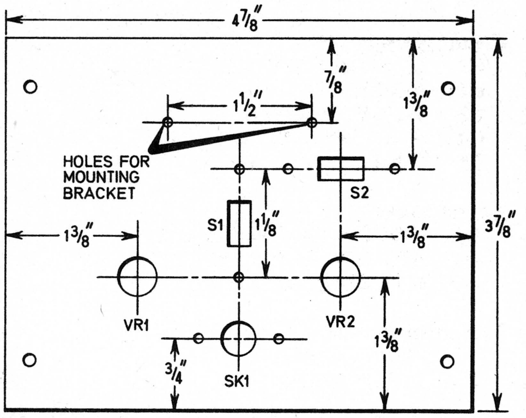
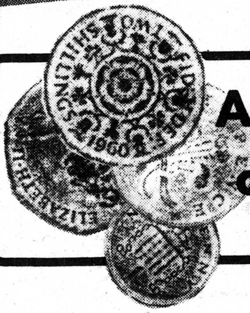
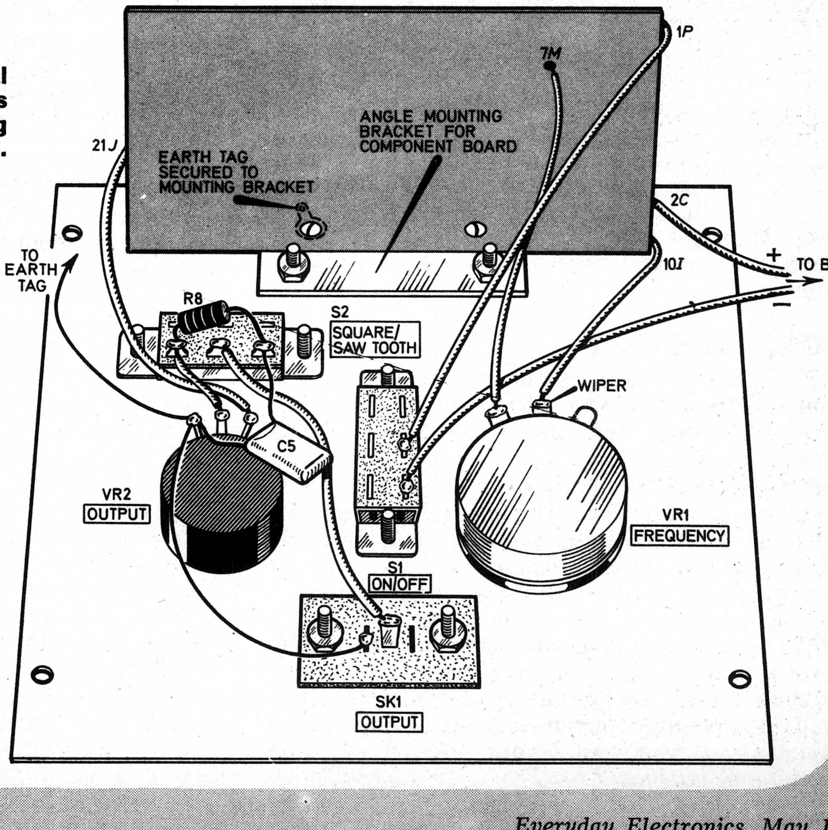


Fig. 5. Front panel drilling details.



Approximate cost of components...
£ 2·60 plus case

Fig. 7. Wiring of the final unit. The tinted area is the component mounting board as shown in Fig. 6.



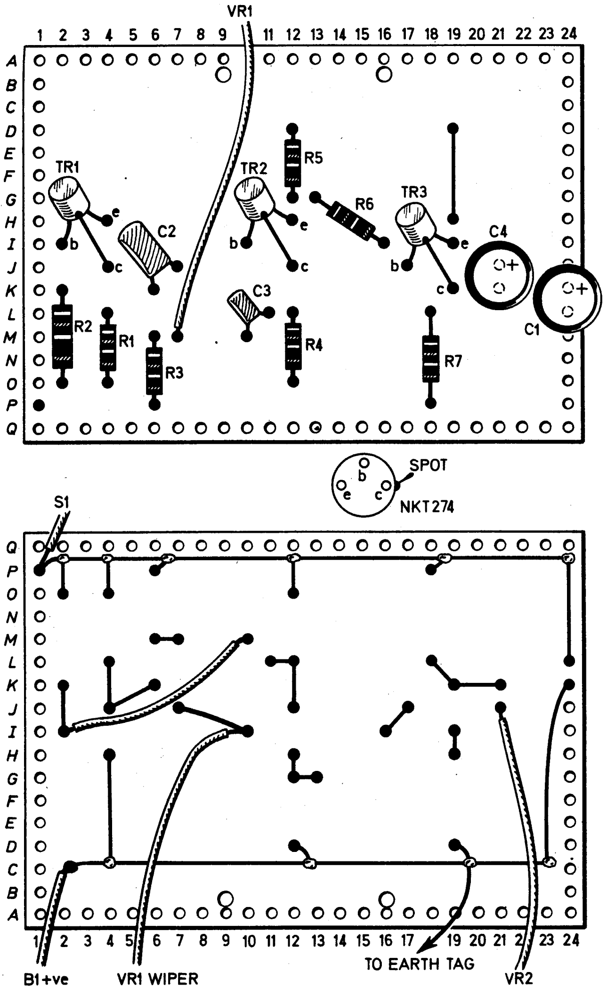


Fig. 6. Top and underside views of the component board. The transistor connections between the two diagrams are viewed from the underside.

flute. Both waveforms are used extensively in electronic organ voicing and for electronic music.

CONSTRUCTION

The prototype unit was housed in a box made from universal chassis parts. The pieces used assemble into a box measuring 5 by 4 by 3 inches. The sides and top and bottom can be assembled leaving one plate for the front panel and one for the rear. The plate used for the front panel is drilled as shown in Fig. 5 and is used to mount all the components.

If the layout and assembly of the generator is as shown there is just room in the case for a PP9 9 volt battery. Even if you spread the layout a little there should still be room for a slightly smaller 9 volt battery. The circuit board is 0·15 inch matrix plain perforated veroboard and is mounted on a 2 inch length of $\frac{3}{8}$ by $\frac{3}{8}$ inch aluminium angle.

Components....

Resistors
R1 2·2kΩ
R2 47kΩ
R3 4·7kΩ
R4 3·2kΩ
R5 100Ω
R6 4·7kΩ
R7 4·7kΩ
R8 15kΩ
All ¼W ±10% carbon

SEE SHOP TALK

Capacitors
C1 50μF elect. 12V
C2 0·05μF
C3 0·01μF
C4 50μF elect. 12V
C5 0·1μF

Transistors
TR1 NKT 274 germanium *pnp*
TR2 NKT 274 germanium *pnp*
TR3 NKT 274 germanium *pnp*

Potentiometers
VR1 1MΩ log carbon
VR2 2kΩ lin carbon

Switches
S1 S.P.S.T. slide
S2 S.P.D.T. slide

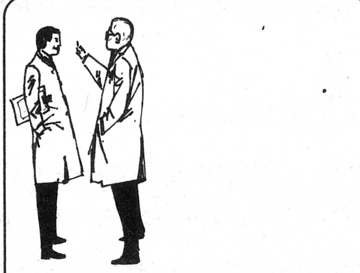
Miscellaneous
SK1 Phono socket
B1 PP9 9V battery
Control knobs (2 off) Eagle type F10, case 5 x 4 x 3in made from universal chassis panels or a similar size case, battery connector, aluminium angle 2 x $\frac{3}{8}$ x $\frac{3}{8}$in. Veroboard 5 x 4 x 0·15in matrix plain perforated, earth tag, connecting wire, 4BA fixings.

Commence wiring of the component board by inserting all components except the transistors, and the wire link on the top of the board as shown in Fig. 6. Turn the board over and connect up the two supply lines along the two sides of the board using 18 or 22 s.w.g. tinned copper wire. Next connect up the remaining components using the component leads where possible and connect the flying leads.

Finally insert the transistors checking carefully the lead connections with the underside view shown in Fig. 6, and solder them to the other components using a heat shunt on each lead as it is soldered. After checking the circuit board mount the board on the aluminium angle bracket and mount this on the front panel together with the remaining components.

Wire up all the components to the circuit board as shown in Fig. 7 and check the completed unit carefully before connecting the battery and switching on.

Continued on page 386



SHOP TALK

By Mike Kenward

This month we have one item which many readers will probably wish to construct but which is not given in the form of a constructional project. It is the simple passive mixer that is described and drawn up in the *Making Electronic Sounds and Music* feature.

Since this is really a bonus that will be useful to those following the article we have not given full constructional details or a components list. All the component values are given on the circuit diagram and the wiring diagram shows how they are put together. The three sockets can be any type suitable for use with your particular tape recorder—the types we have shown are phono sockets.

The complete unit can be mounted in any small case. No battery or power supply is necessary. We would like to emphasise that this is a simple passive mixer and will not be able to cope with all inputs.

A more advanced type of mixer may form the subject of a future article. However this simple mixer should be suitable for use with the *Audio Tone Generator* that is also described in this issue.

Audio Tone Generator

There should be very few buying problems for the *Audio Tone Generator*. As described above the sockets could be changed to any suitable type if your equipment does not use phono sockets or if you already have other types. Once again the case for this project can be any type that is available in a suitable size.

Bee Counter

We find it difficult to comment on the availability of cedar wood —not after-shave—but apparently this wood must be used or the bees will not accept it!

As far as the remaining components for the *Bee Counter* go make sure that the resistors you buy are of adequate wattage. The lamp and holder should be of the miniature type so that they can be accommodated in the wooden base panel. Since the current drawn by this circuit is fairly large the section in the article concerning the battery should be noted.

There are a number of Post Office type counters available so make sure you get the right one —4·2 ohms coil resistance is the important thing.

Metal Locator

The *Metal Locator* is a project which we are sure will create great interest but please remember that this is a simple one-transistor design and cannot be expected to out-perform a £30 unit. The use of Perspex or Paxolin is recommended for the locator head as these materials are not affected by damp or water.

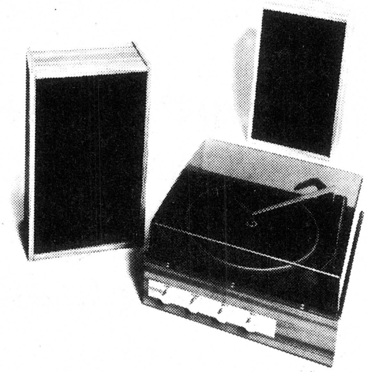
All remaining components for the locator should be readily available. The use of a subminiature switch is recommended since only a small hole then needs to be cut in the plastic beaker. Any 50μA moving coil meter could be used in the locator provided it will fit the beaker lid. The one specified is probably the cheapest.

Finally do not forget the operating licence and don't say we did not tell you!

New Products

Two products from one go-ahead firm have been introduced this month. Both in the audio field, possibly the most outstanding is the Unisound 505 as Radio and T.V. Components call their do-it-yourself £25 stereo system. This competitively priced unit comes as a complete kit and only needs two screwdrivers to put together. All the electronics are in module form and are supplied with wiring looms that only need connecting up using a screwdriver supplied with the kit.

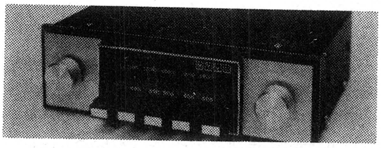
The large EMI speakers are housed in attractive cabinets again put together with only a screwdriver. It is said that anyone who can wire up a mains plug can put the system together in one evening. The system utilises modified Mullard Unilex modules, has an output of 3·7 watts continuous sine wave r.m.s. per channel; and frequency response of 40Hz to 20kHz at the 3dB down points. It would be very difficult to buy the individual components —including Garrard 2025TC deck, cartridge, plinth and cover and build a unit to match this one for £25, excluding the two speakers and cabinets.



The second unit from RT-VC is a £7 push button car radio kit, slightly more difficult to construct but any reader who has some experience of soldering should be able to build a working unit.

The kit is of good quality and uses the same push button tuning unit as radios costing three or four times the price. These features ensures good sensitivity and the pre-aligned i.f. (intermediate frequency) module and tuner avoid complicated alignment.

The kit is suitable for 12V positive or negative earth operation and readers may like to note that an after sales service—to repair any item not functioning correctly—is operated by RT-VC for all their kits; cost about £2 depending on the fault.



Making Electronic Sounds and Music

BY FRED JUDD

Simple experiments with a tape recorder

THE term "electronic music" almost defies explanation because it is not the music that is electronic but the equipment and methods of creating it.

Its origin goes back many years, in fact to the invention of the thermionic valve and even as early as 1921 a "concert" of electronic music was performed in Paris by an Italian, Luigi Russolo, who used what was then called electrical sound generating and reproducing equipment.

Electronic music was difficult to perform directly from sound generators, etc., because composition required arranging the sounds in a given order and even changing the order, and sometimes the sounds, at a later time.

MODERN METHODS

Magnetic tape recording finally provided the ideal medium for composition. The sounds required could be recorded and rearranged afterwards by simply cutting out the pieces of tape containing them and splicing these together again in the order required. This technique paved the way for composers who, with both electronics and magnetic tape at their disposal, could produce new kinds of music with tonal qualities never before possible.

More recently of course the music synthesizer has taken over the task of tone generation, etc., and electronic music composers can now programme a synthesizer, couple it to a tape recorder and produce "instant" electronic music.

Nevertheless there is much that can be accomplished by the amateur with an ordinary domestic tape recorder, an audio tone generator (like the one described on page 358) and some splicing tape. The techniques are simple and you can get a good deal of fun out of experimental electronic music and "science fiction" sounds.

Your efforts need not be wasted either because you can enter them for the experimental music and sounds section of the annual British Tape Recording Contest (details later).

EQUIPMENT

An ordinary spool to spool tape recorder is the main requirement and if you have a stereo recorder with provision for recording independently on either track or you can get together with a friend and use two tape recorders, so much the better. A tape recorder with track-to-track or duoplay facility is also advantageous especially if it permits echo effects.

It is not possible to lay down procedures for specific makes and types of tape recorder but you will find that most of the techniques described can be applied.

Note that cassette or cartridge tape recorders are of limited use for creative recording of this nature which requires fairly extensive tape cutting and splicing.

Most modern spool to spool tape recorders are designed for stereo operation employing half or quarter track on standard quarter inch wide tape. If the tape recorder has a track-to-track recording facility it will have separate recording and replay heads, thus allowing a recording on one track to be copied on to another together with other signals.

Some stereo recorders may only have a common record/replay head which will not normally allow track-to-track copying but may have a facility for making separate recordings on each of two tracks. Information concerning such facilities should be given in the tape recorder instruction book. If in doubt, you should contact your dealer or the manufacturer for such information.

AUDIO TONE GENERATOR

An audio tone generator is not absolutely essential but is most advantageous. The simple *Audio Tone Generator* described on page 358 is quite suitable as it covers a wide enough frequency range and will deliver a square-wave or a nearly sawtooth-wave output signal, thus providing two basic sounds.

Sounds picked up by a microphone can also be used because these can be reshaped by tape cutting and splicing and by certain recording techniques. Magnetic tape will be required of course and for initial experimental work low priced brands will suffice.

Some splicing tape and blank leader tape will also be required. Do not use ordinary plastic sticky tape, such as Sellotape, for splicing as this may damage the tape and will not give a long lasting joint. Small kits of coloured leader and proper splicing tape are readily available. A small tape splicer is also a very useful, though not essential, tool.

FIRST EXERCISES

It is important to know the extent to which your tape recorder can be used. If it has two or three speeds, as most of them do, record some musical sounds, whistling will do, at all three speeds and then play them back at one speed only, say the highest.

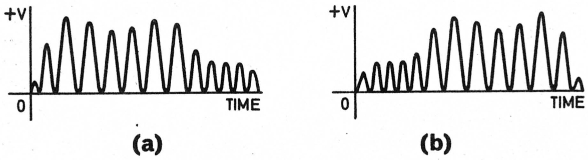
The sounds recorded at the lower speed(s) will be raised in pitch, by one or two octaves, depending on the speed. If the replay speed is double that of the recording speed the pitch is raised one octave and the sounds will occur faster but if the replay speed is half the recording speed, the pitch will be reduced by one octave and the sounds will occur slower. This is one of the most simple but most used techniques.

REVERSE REPLAY

Now, if your recorder is a stereo machine try turning the tape over (reverse the spools) and see if you can obtain replay on another track in reverse, i.e., the sounds will be going backwards. This technique is also commonly used for electronic music because it alters the nature of the sound completely by placing what was the beginning of the sound, i.e., its attack, at the end as illustrated in Fig. 1 in which (a) is the sound as recorded and (b) as played in reverse.

If you cannot play sounds in reverse try this exercise; connect a tone generator, or if this is not available record whistles through a micro-

Fig. 1. (a) Original waveform of the recorded sound (b) The sound recorded and shown in (a) played in reverse.



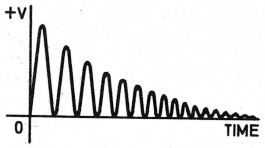


Fig. 2. Waveform of a sound which starts instantly and slowly dies away.

Photograph showing the use of a tape splicer to join up a number of sounds.

Recording various sounds, using the microphone, to form a composition.

phone. Start with the recording level control at the maximum, set the tape running to record the sound but then almost simultaneously slowly turn the record level control to zero.

On replay you will have a sound that starts instantly and then slowly dies away as in Fig. 2. With a little practice you will be able to get various dying away or decay times depending on the speed at which the recording level control is turned off. Now try the reverse procedure; gradually increase the sound whilst recording and then quickly stop it.

TAPE CUTTING EXERCISES

Now try some tape cutting; first use the highest tape speed and record a few sounds of different pitch, i.e., from a tone generator, or whistles via the microphone, each one lasting two or three seconds.

Locate the beginning of each sound on the tape by carefully feeding the tape across the head and then cut the tape about two inches in front of the sound. Run off the remainder until you reach the beginning of the next sound; cut the tape here and splice to the end of the piece containing the first sound. Cut and join pieces of the remainder of the sounds.

On replay you will have a series of short sounds each rapidly following the other. Now try a similar exercise but this time insert pieces of blank leader tape between each sound.

MUSIQUE CONCRÊTE

Finally a variation of the two previous exercises. Record a few sounds each at a different tape speed. These should preferably be musical sounds, such as whistles or tones, or sounds produced by tapping a wine glass for example. Cut one or two pieces of each from the tape and assemble them at random with pieces of blank leader between groups. The pieces may be long or short.

Try replaying the assembled tape at different speeds and note the effect. You are well on the way to a form of composition known as "musique concrête" which is the creation of abstract forms of music out of real sounds. The same technique can, however, be used for abstract forms of electronic music in which the main sound source is an audio tone generator.

USING A TONE GENERATOR

The exercises outlined above demonstrate how almost any recorded sound can be altered by tape cutting and by recording and replay at different tape speeds. Electronic music does not normally include natural sounds recorded via a microphone and therefore the sound sources are electronic, i.e., from tone generators of one kind or another. The recording and tape cutting techniques, however, remain the same.

If you have a full range audio signal generator then tones can be recorded at the pitch required. The simple generator described on page 358 has a frequency range of approximately 50 to 2000Hz.

If frequencies outside the range of the generator are required it is simply a case of recording and replaying at different tape speeds for example; if a frequency of around 4000Hz is required, record the highest pitch of the generator (approximately 2000Hz) at a tape speed of $3\frac{3}{4}$in/sec (inches per second) and replay at $7\frac{1}{2}$in/sec.

If a very low pulsing sound is required at say 20 to 25Hz record a square-wave signal from the generator at its lowest pitch and then replay the recording at half the speed. Some experiment in this direction will soon reveal the tonal and pitch ranges that can be obtained simply by recording and replaying at various tape speeds.

Once this has been done, further experiment with the audio tone generator can be carried out in order to discover the type of sounds that can be produced. Start by recording a continuous note and while recording this vary the frequency and output controls on the generator, try this for both the square and sawtooth outputs (note that the output in the sawtooth position is much lower than in the square wave position).

Try cutting and reversing the sounds recorded to obtain various effects. You can also try making recordings at a distorted level by turning up the record level control, this will distort the original sound and produce yet another effect. Try switching from one output waveform to the other whilst recording—you can vary frequency and output at the same time—and also try switching the generator on and off while recording, again you can vary the output and frequency whilst turning on and off.

Edit the sounds produced by cutting and splicing and experiment fully with all possible

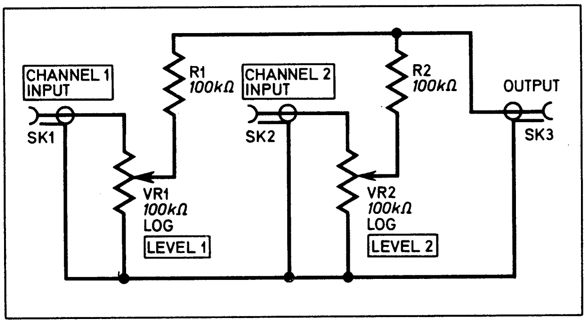


Fig. 3. Circuit diagram of a passive mixer that can be used for making electronic music.

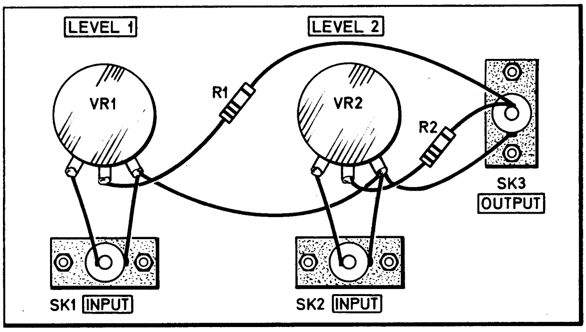


Fig. 4. Constructional details of the circuit shown in Fig. 3. Shop Talk refers to this figure.

effects. Once you have done this and feel fully conversant with the various effects that the generator is able to produce you can start to add one effect to another.

SIGNAL MIXING

Recording from track-to-track or using two separate tape recorders may necessitate mixing signals that are to be recorded and re-recorded i.e., signals from a recording already made to be mixed with signals from another source such as the tone generator.

Some recorders have built-in mixing facilities whilst others may permit a form of mixing by using the track-to-track recording facility or by superimposing one sound on another previously recorded. Again the tape recorder instruction book will provide information of this nature.

However, it is possible to build a very simple mixing circuit as shown in Fig. 3; Fig. 4 shows the construction. This is known as a passive mixing network, but will alow two signal sources to be mixed at different levels and coupled to a common input on a tape recorder (Fig. 5).

TAPE LOOPS

Another interesting technique widely used for electronic music is the tape loop. This is the use of a small endless loop of tape containing recordings which are played continuously to produce repeating rhythm patterns.

Record a few natural sounds, or low pitched tones from an audio generator, of quite short duration, one immediately after the other. Cut a piece of the tape containing the sounds, about 18 inches long, and splice the ends together so as to form a complete loop. Place the loop in the recorder so that it runs past the tape heads when the machine is set to replay. You can hold the loop under tension by one of the methods shown in the photographs. Try running the loop at different speeds and, if possible, reverse the direction.

Record some percussion sounds, e.g., sounds produced by knocking together empty boxes, etc. Cut out pieces and make up a loop consisting of the various sounds and blank leader tape. For the first attempt use only two or three sounds and two or three pieces of leader.

You can make up an almost endless variety of fascinating rhythm patterns by this method and if you use two tape recorders the rhythm loop can be copied from one to the other whilst other sounds are added.

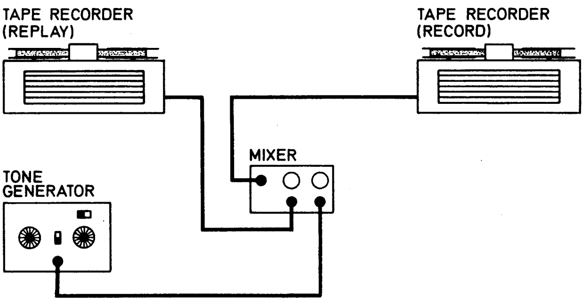
MULTIPLE RECORDING

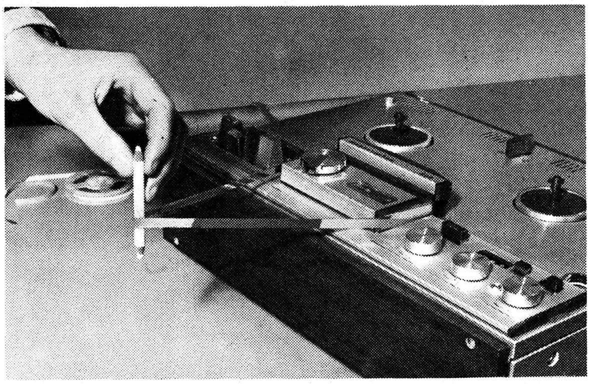
If you have a tape recorder with a track-to-track recording facility the scope is much wider as sounds may be recorded on one track and then re-recorded on to another track whilst adding more sounds. If your tape recorder can produce the echo effect this too can be used in various ways to produce those echoing science fiction sounds. Try allowing the echo to build up into a crashing roar and see if you can play it in reverse.

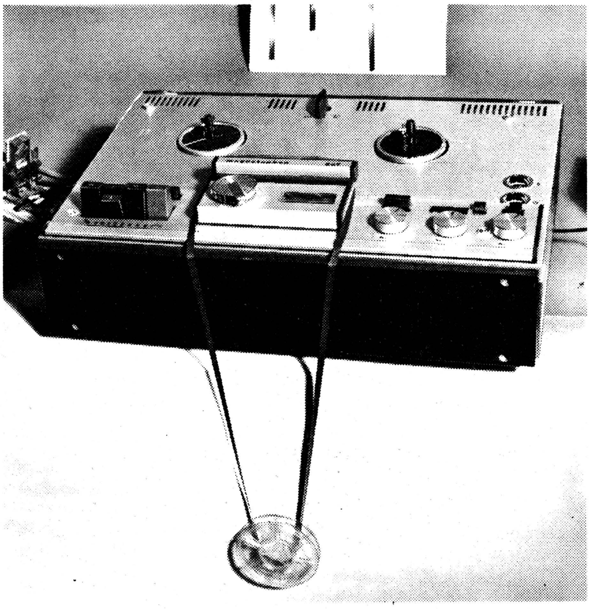
Now that you have discovered the variety of sounds and rhythms available using the facilities you have it is up to you to put these together to form an interesting "musical" passage. It may take some time before you achieve the required effect.

By combining even a few of the techniques outlined the number of permutations possible are fantastic. Instructions on composition cannot be given because no rules exist. Your ideas must come solely from imagination and experiment.

Fig. 5. Using the passive mixer to combine two signals for recording purposes.







The three photographs on the left illustrate various methods of using a tape loop. The top photograph shows a reversed loop held under tension by passing it around a pencil; this is only suitable for short periods.
The centre photograph shows a reversed loop held under tension by a small spool hanging over a table edge; this is only suitable for fairly large loops.
The lower photograph shows a system that can be used for any size loops by routing the tape around suitable objects—batteries are shown. This photograph also shows a cardboard tape holder used to keep recorded sections of tape in the order required.

COMPETITION

Finally, why not try an entry for the "technical experiment class" of the annual British Tape Recording Contest. It is open to anyone and the closing date for the 1972 contest is not until June 30. The Technical Experiment class allows for tapes of up to 4 minutes duration and includes; sound composition, electronic music, musique concrête, multi-track music and experimental sound recordings. The prizes are worthwhile and you can get an entry form free by writing to The Secretary, British Amateur Tape Recording Contest, 33 Fairlawnes, Maldon Road, Wallington, Surrey, and enclosing a stamped addressed envelope. You may also be interested to know that the special "Tape of the Year" award for 1971 was for an experimental class entry.

Every tape entered is carefully assessed by the expert judges and their comments are passed to the contestant concerned when the tape is returned. Thus you will know how to make an even better tape next time. ▣

PLEASE TAKE NOTE

The approximate cost of components given in the Simple Calculator article last month was incorrectly shown as £1·20. This should have been £2·20.

The probe flying lead in the Signal Injector article (March issue) should be soldered to Y3 not Y2 as stated in the text.

The Normatest 2,000 multi-range test meter mentioned in Shop Talk last month is available from: Croydon Precision Instrument Company, Hampton Road, Croydon, CR9 2RU.

THEY MADE THEIR MARK

No1 Introduction By J. E. Gregory

ELECTRONICS is an internationally uniform world of symbols. Look at any advertisement or study the simplest circuit diagram in EVERYDAY ELECTRONICS and you will be confronted with strange symbols of every shape. Magical signs used to signify basic units of physical quantity; Table 1 lists some of them.

Although electronics is regarded as a modern science and hobby many of these units are named after pioneers, scattered throughout the world, whose accumulated research spans hundreds of years.

This series sets out to explain the symbol, and perhaps more important something of the man who gave his name to it. But let's begin our potted history of electronics at the beginning.

THE GREEKS HAD A WORD FOR IT

Take the word electronics itself, for that we must go back in time to ancient Greece. To the ladies of Greece passing time by decorating their spinning wheels with amber, found on shores in the far north. They observed that the amber when contacting the threads would draw the threads to itself as they separated from the wool, and then push them away in a frictional force. The Greek word for amber was elecktron, from the verb elkein to attract. Although this phenomenon was observed and noted by several of the great Greek philosophers we have to jump two thousand years to the early 1600's and to the reign of Good Queen Bess, who was persuaded by her physician William Gilbert, to attend a demonstration of a frictional electric machine based upon the power of amber to attract. This power he called electricity.

It was soon realised that the crackling and sparking of Gilbert's electric machine were the same phenomena on a minute scale, as thunder and lightning, but how to prove it?

THE KITE FLYER

One of the first to try was the fifteenth child of an English immigrant; born in Boston Massachusetts in the year 1706, this was the well known American statesman and philosopher Benjamin Franklin (see illustration above).

His historic but dangerous experiment trying to capture electricity from the sky occurred during a thunderstorm in the summer of 1752, when accompanied by his small son, he flew a kite with an iron door key. During the storm, he saw that sparks sprang from the key to his wrist, what he didn't realise of course was that if the lightning had actually struck the kite he would have been killed.

The study of natural phenomena had to take second place to his other activities, but he came to the conclusion that thunderstorms were simply the levelling of opposed electrical potentials, between one cloud and another or between a cloud and earth.

It was Franklin who introduced the positive and negative signs for electric charges, realising there are two kinds which neutralise each other.

Next month we move from America to 18th Century Italy and a scientist, Alessandro Volta, after whom the Volt, the measurement of electrical potential is named.

Photograph: Science Museum, London.

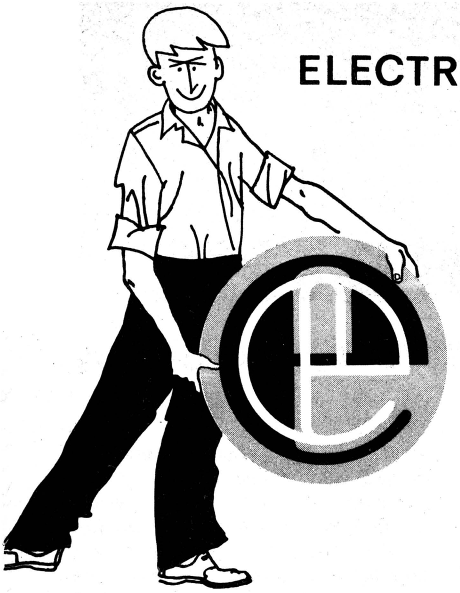
Table 1 FUNDAMENTAL UNITS

unit symbol	name of unit	physical quantity
A	Ampere	Electric Current
V	Volt	Electric Potential
F	Farad	Electric Capacitance
Ω	Ohm	Electric Resistance
W	Watt	Power
Hz	Hertz	Frequency
H	Henry	Inductance

These basic units are often inconveniently large or small and the units are prefixed with the following symbols:

p	pico	÷ 1,000,000 million
n	nano	÷ 1,000 million
μ	micro	÷ 1 million
m	milli	÷ 1,000
k	kilo	× 1,000
M	mega	× 1 million
G	giga	× 1,000 million

Hence 5kV = 5,000 Volts ; or 5mV = 0·005 Volt



ELECTRONIC CIRCUITS–
.....IN THEORY and PRACTICE

TEACH-IN
...FOR BEGINNERS

By Mike Hughes M.A.

7 SEMICONDUCTORS: Transistors

THIS year sees the twentieth birthday of the component most responsible for bringing electronics within the scope of do-it-yourself enthusiasts; it has greatly simplified design and construction and has also brought about terrific reductions in costs. It is the "transistor".

As a replacement for the valve, it allows us to use low voltages and removes the arduous task of having to assemble valve bases and massive transformers on tank like chassis. Connections to a transistor are few and the basic way it operates in a circuit is quite easy to understand.

PNP—NPN

The transistor is a member of the semiconductor family and is basically a sandwich of different types of either silicon or germanium. The "filling" of the sandwich can either be *p*- or *n*-type material; we can clad a *p*- type filling with *n*-type material giving what we call an *npn* transistor. Alternatively a *pnp* device is made by filling a *p*- type material with an *n*- type.

One encounters both types in practice but nowadays *npn* devices made from silicon predominate, the reason being that they are easier to make and hence cheaper!

Fig. 1(a) shows a diagramatic cross-section of both types of transistor, *pnp* and *npn*. One end is heavily doped and is called the "emitter"; the other end is lightly doped and called the "collector".

The filling material is very thin in practice (usually one or two microns; 1 micron is a millionth of a metre) and is called the "base". In its simplest form you can think of an *npn* device as two diodes connected together by their anodes (back-to-back), and facing each other in a *pnp* device, Fig. 1(b).

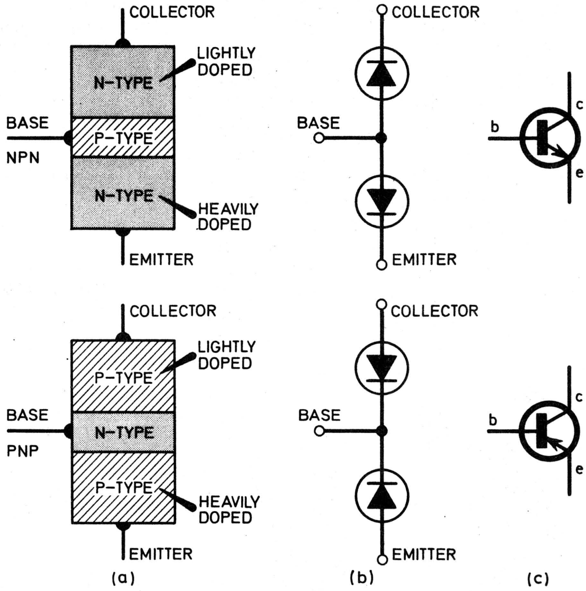


Fig. 1. (a) Schematic diagram of the internal make-up (b) equivalent representation and (c) circuit symbol for (top) *npn* transistor and (bottom) *pnp* transistor.

BASE CONNECTIONS

All the transistors you will come across have connections brought out from the emitter, base and collector. A very common silicon *npn* device is the BC108 and we shall be referring to this frequently in this series.

Fig. 2 shows what it looks like. If you have one handy see if you can identify which lead is which.

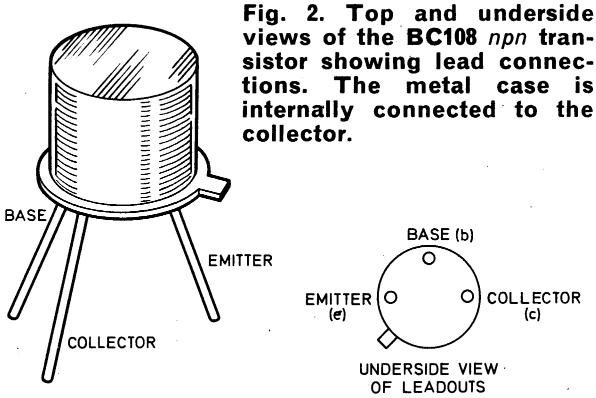


Fig. 2. Top and underside views of the BC108 *npn* transistor showing lead connections. The metal case is internally connected to the collector.

The emitter is the one closest to the spigot on the side of the can, the collector is diametrically opposite, and the base is between the two but set off to one side. This is a metal can transistor and the can is electrically "live"—in actual fact it is connected to the collector as well as the lead out wire.

Different types of transistor may have different shaped cans and some are in plastic encapsulations. Always make sure you know which lead is which before you start using a transistor.

Most constructional projects in EVERYDAY ELECTRONICS give you lead designations for the transistors specified, but if you want to experiment with alternative types make sure you know the correct base lead connections.

SIMPLE TEST

Use the BC108 *npn* transistor to identify the effect of the two diodes connected back-to-back. First of all make an ohmmeter on the Demo Deck. Use a 4·5V battery (**not** 9V) in series with a 2·2 kilohm resistor and VR2 (5 kilohm). Complete the circuit and set VR2 to give zero ohms at full scale deflection and then connect the leads of your ohmmeter between the base and emitter connections of the transistor—to do this it is best to solder the transistor on to three adjacent pins of the Demo Deck and use crocodile clips on the leads from the meter.

If you connect the meter so that the lead coming directly from the negative terminal of the battery goes to the emitter, the meter needle will move to almost full scale showing there is little resistance in the transistor. Now reverse the leads so that the base is more negative than the emitter—you should see that no current flows (indicated by meter needle not moving). Thus the base-emitter junction is a diode and follows the same rule that we saw last month.

Now leave the lead on the base and transfer the one from the emitter to the collector—again no current flows but reverse the leads and current flows between the base and collector.

If you connect the leads between the collector and the emitter no current should flow whichever way you have them because in both connections, the current would have to pass through a reverse biased diode.

This simple experiment can be used as a rough and ready test to check if a transistor is likely to be in working order, and provided you remember the rule "make p stand for positive for current to flow" you can use it to identify *npn* and *pnp* transistors.

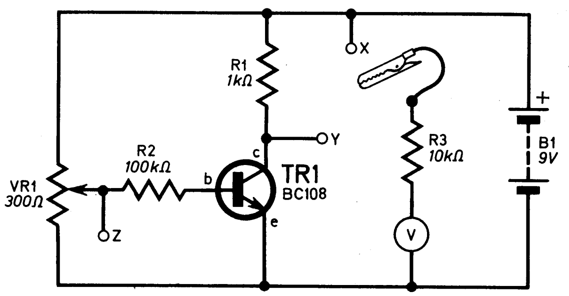
REVERSE VOLTAGE LIMITS

Like all diodes, the junctions of a transistor have reverse voltage limits. These are usually specified with abbreviations. For the BC108 the reverse emitter-base voltage (V_{ebo}) is 5V—i.e. you must never make the base more than 5 volts negative with respect to the emitter (this is why we had to use 4·5V for our ohmmeter instead of the 9V we have been used to). Likewise the reverse base/collector voltage (V_{cbo}) is 30V. You might expect the reverse voltage between the emitter and the collector to be equal to the highest of the other two but this is not the case—it is lower—for the BC108 V_{ceo} is 20V.

The "O" in the suffixes of the reverse voltage characteristics indicates that the third terminal is "open circuit" i.e. not connected.

HOW THE TRANSISTOR WORKS

Let's see what a transistor actually does by using the circuit of Fig. 3(a). Now that we are using the transistor in a real circuit it is important to note the polarity of the supply voltage—for an *npn* transistor the collector must **always** be kept more positive than the emitter (the converse applies to *pnp* devices). We are going to make the transistor work like a tap and control the amount of current flowing through R1. You can see this happening if you follow the details through on the Demo Deck.



VR1 is a 300 ohm potentiometer working as a potential divider giving us a variable supply at its wiper.

Wire up the circuit of Fig. 3(a) on the Demo Deck as shown in Fig. 3(b), but do not connect R2 to the base of the transistor just yet.

Resistor R3 and the 1mA meter makes a 10V range voltmeter in the usual way. Connect the negative lead to the emitter of the transistor. All voltages we measure will be relative to that of the emitter.

First measure the power rail at point X—it should, of course, be +9V; now measure the potential at the collector of the transistor (point Y) it should be +8·2V. This is what is expected because no current can flow through the back-to-back diodes of the transistor, but the meter will draw some! If you had a high sensitivity meter (say 20 kilohm per volt) this current would be negligible and you would see +9V at both points, X and Y.

Now set VR1 so that the potential on its wiper is zero (with respect to the emitter) and connect R2 to the base of the transistor. VR1 potential is measured by attaching the crocodile clip from the meter to point Z. Again measure the potential at the collector—it should not have changed.

We shall now see what happens if we increase the potential at the wiper of VR1. Do this in 0·5V increments (use crocodile clip at point Z) and for each setting measure the collector potential. You should see that once the potential of the wiper exceeds 600mV, the potential at the collector falls, and continues to fall towards zero as the controlling voltage is increased. Once the collector potential reaches almost zero no more control can be effected. We say that the transistor is now fully conducting between collector and emitter. This state is called "saturation."

Record your results and plot a graph of collector voltage versus voltage at the wiper. A graph should be obtained similar to that of Fig. 4.

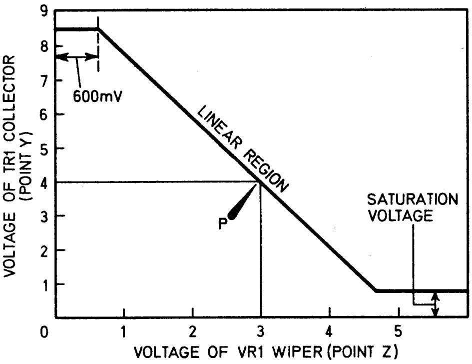


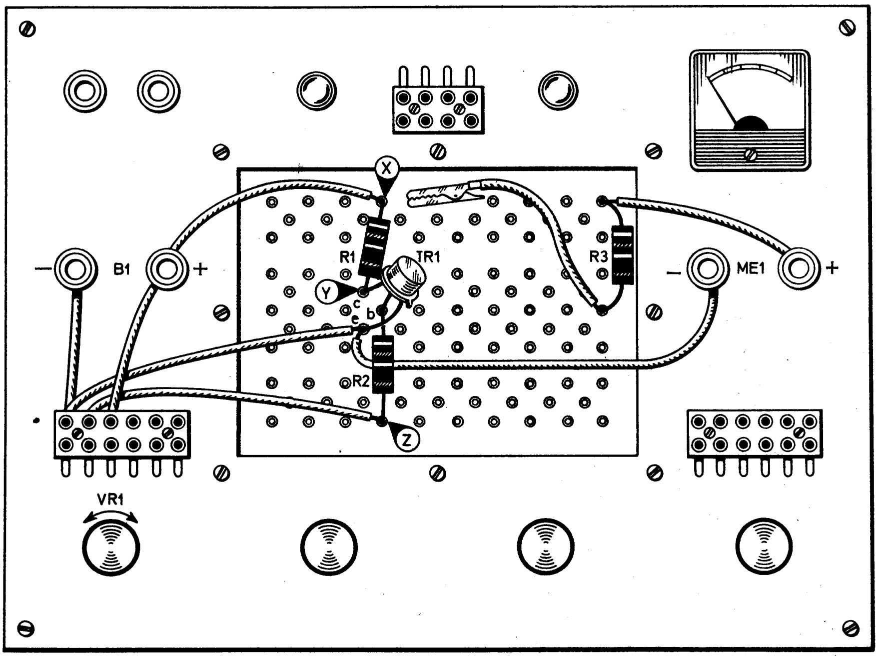
Fig. 4. The graph obtained by plotting the recorded results of experiment using circuit of Fig. 3(a), i.e. voltage at point Y versus voltage at point Z.

Control of the collector/emitter current is brought about by passing a current through the forward biased base/emitter junction. The more current we pass into the base in this way, the more current we can control between the collector and the emitter. The controlling current is called "base current," (I_b) and the controlled current "collector current," (I_c).

Base current is set by the potential difference between the wiper of VR1 and the emitter of the transistor, acting through the resistance R2

Fig. 3(a) (left). The circuit diagram used for investigating some of the properties of a BC108 transistor.

Fig. 3(b) right. The circuit of Fig. 3(a) wired up on the Demo Deck.



and any internal resistance between base and emitter. The latter is small and can be neglected at this stage. We must, remember, however, that the base must be made at least 600mV positive with respect to the emitter before any current can flow (this is the usual forward voltage drop for any silicon junction).

We can thus calculate the current flowing into the base by measuring the potential at the wiper of VR1, subtracting the base emitter forward voltage drop (600mV) and dividing by the value of R2.

GAIN

If you do this for your experiment you will find that the base current ranges from 0 to 0·084mA. The range of collector current we are controlling was from 0 to 9mA. It can be seen that the transistor enables us to use a very small current to control a larger one. We call this effect "current amplification." The factor that governs the ratio between I_b and I_c is called "gain" and although it increases with I_c it is pretty well constant for any given transistor. It can, however, vary widely between different types of transistor and even between devices having the same type number! Provided you take a combination of base and collector currents within the controllable region (this is called "linear region") you can calculate the gain of the transistor you are using.

It would be best to increase the potential at VR1 until the collector potential is approximately 4V. This reduces the shunting effect of our voltmeter.

Use the precise values of voltage measured to calculate the current through R2 and R1 then use the ratio of these values to calculate the gain.

gain = collector current ÷ base current

$= I_c \div I_b$

For the BC108 transistor it should be approximately 200, but as we have said, will vary from device to device.

Example To calculate the gain from your plotted curve (similar to the one of Fig. 4) select a convenient point on the linear region such as point *P* of Fig. 4.

The base current, I_b is given by the voltage difference between the base and emitter divided by the base resistor.

$$\text{i.e.} \frac{3-0\cdot6}{100{,}000} = 0\cdot024\text{mA}$$

Now the voltage drop across the collector resistor R1 is $(9-4)\text{V} = 5\text{V}$. Therefore, collector current I_c is $(5 \div 1000) = 5\text{mA}$.

Substituting these values for I_c and I_b in equation (1) gives the gain $= (5 \div 0\cdot024) = 208$.

There are various ways of describing current gain for a transistor so we shall define that measured above a little more precisely—it was the d.c. current gain. This is sometimes abbreviated to the designations β (beta) or h_{FE}. The latter is rather a strange type of designation but is one of a range of what are called "h" parameters—we need not worry ourselves about these in this series except for the term h_{FE} which is usually used in manufacturer's data sheets. Do not confuse h_{FE} with h_{fe}, the latter is called the small signal current gain and we shall not be dealing with this until later.

The gain equation above can be rewritten: $I_c = h_{FE} \times I_b$

Remember that the experiment we have just done has been using a silicon *npn* device. We could have used one made from germanium having *npn* structure and obtained a similar effect—except that the base/emitter forward voltage drop would have been only about 200mV and h_{FE}, in general, would have been lower.

We could also have used a silicon or germanium *pnp* device but would have had to reverse the battery connections so that the collector was negative with respect to the emitter. The same rules would have applied and we could have still calculated a value for h_{FE}.

If you are a little confused by the difference between *npn* and *pnp* devices do not worry too much as this stage—most of the early experiments in Teach-In will use *npn* devices and when you have got used to these you will find it quite straightforward to switch over to *pnp* devices when necessary. The most important thing to remember is the polarity of battery voltage when using one type or the other. An aid to remembering what the polarity ought to be is to bear in mind the direction of conventional current flow;

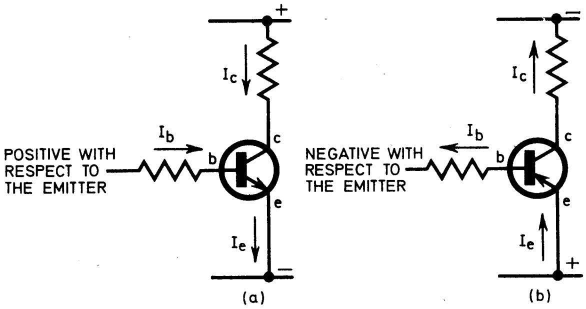


Fig. 5. Circuits showing major current flow directions for (a) *npn* and (b) *pnp* transistor. I_b—base current, I_c—collector current, I_e—emitter current.

the arrow on the emitter of the symbol points in the direction of current flow, i.e. it points away from positive and towards negative. See Fig. 5.

Whether using *npn* or *pnp* devices an aid to remembering how to turn collector/emitter current "on", is to make the potential at the end of the resistor connected to the base tend towards the same polarity voltage as applied to the collector; the more you move towards this voltage, the more I_b increases, and I_c will increase in direct proportion.

When the potential feeding the base rises towards the supply voltage the voltage at the collector falls towards the emitter voltage. This is called "inversion."

In Fig. 3 R1 is called the "collector load." The limit of I_c control is set by the value of this resistor; if it has a high value then it does not matter how much base current you apply, you cannot control more collector current than that given by the collector supply voltage divided by the value of collector load. On the other hand, if the load is too low you might find yourself trying to force more collector current than the construction of the transistor can handle. Thus one of the specifications of a transistor is the maximum collector current it can handle without "blowing". This is called I_{cmax} and for the BC108 is 100mA.

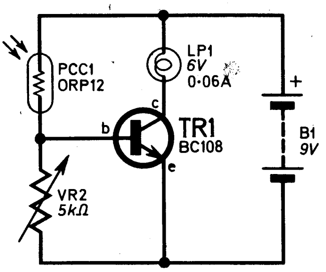
A final parameter we must deal with is the power rating of a transistor. As current is passing through it a certain amount of heat is dissipated. We already know that too much heat can spoil the properties of a semiconductor so it must be limited. The limit is set by the maximum power dissipation parameter, P_{cmax}. It is easy to calculate what the power dissipation is likely to be; it is the dissipation you would get if you replaced the transistor in the circuit with a resistor having the same ohmic value as the collector load.

Table 1 gives you some typical values of parameters for some common transistors of varying types, powers and polarities.

Table 1: THE MORE IMPORTANT CHARACTERISTICS OF SOME COMMON TRANSISTORS

Type	Polarity	$P_{c\,max}$	V_{cbo}	V_{ceo}	V_{ebo}	$I_{c\,max}$	h_{FE}
BC108	*npn*	300mW	30V	20V	5V	100mA	240
2N2926	*npn*	200mW	18V	18V	5V	100mA	150
BFY51	*npn*	800mW	60V	60V	6V	1A	70
BFX13	*pnp*	300mW	−20V	−15V	−5V	100mA	120
2N3702	*pnp*	360mW	−40V	−25V	−5V	200mA	60
AC126	*pnp*	500mW	−32V	−32V	−10V	100mA	100
OC72	*pnp*	125mW	−16V	−16V	−3V	125mA	50
OC26	*pnp*	12W	−16V	−16V	−10V	3·5A	50
OC36	*pnp*	30W	−80V	−32V	−40V	10A	70

Fig. 6(a) (below). The circuit diagram of the "Electronic Candle" which illustrates positive feedback.
Fig. 6(b) (right). The circuit of Fig. 6(a) wired up on the Demo Deck. Ensure that PCC1 is close to LP1.



ELECTRONIC CANDLE EXPERIMENT

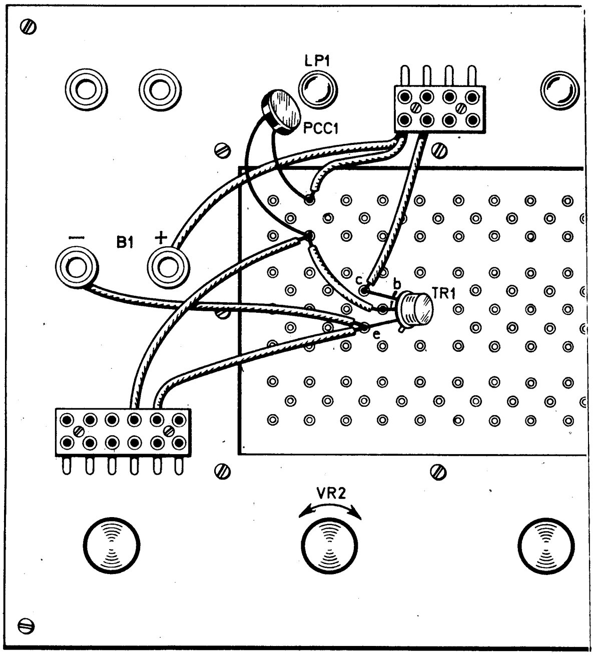
We shall now make a simple working circuit using the circuit diagram of Fig. 6(a). This is wired up on the Demo Deck as shown in Fig. 6(b). Connect the ORP12 (light dependent resistor) very close to the LP1 on the Demo Deck as shown below. Set VR2 to zero ohms. The potential at the base of TR1 will be zero, therefore no current will flow between collector and emitter. Now, in a reasonably lit room, increase the value of VR2. At a certain point the potential at the base will reach 0·6V (set by the potential dividing effect of PCC1 and VR2) and the transistor will start to conduct (the bulb will glow dimly).

Continue to increase the resistance of VR2; the current flowing through PCC1 will now pass into the base/emitter circuit of the transistor in preference to the higher resistance path through VR2. This base current will cause TR1 to pass more collector current until the bulb is fully illuminated.

When you reach this point (the minimum value of VR2 that will give full illumination) try casting a shadow over PCC1, the lamp will go dim and ultimately go out altogether as I_b reduces due to the resistance of PCC1. We did a similar sort of thing in Teach-In Part 4.

The difference is that we now have a circuit that is much more sensitive to small changes in light level which is brought about by the transistor amplifying the current from the photo resistive cell.

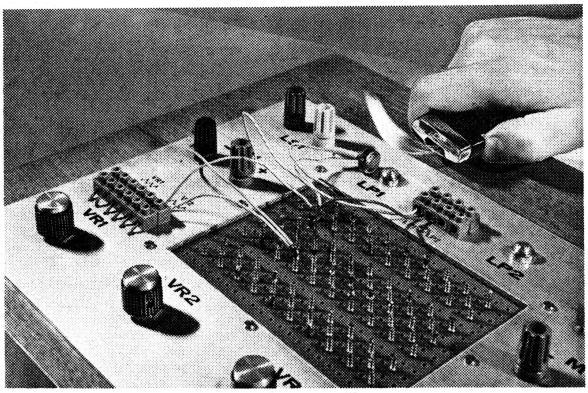
If you place the cell very close to the bulb in a dimly lit room you can set the value of VR2 so that the ambient lighting does not turn the transistor on, but the light from the bulb will.



Break the light path between the bulb and the cell and the bulb goes out and stays out. Now use a match or lighter to provide a stimulus of light. Bring it close to the bulb/cell assembly and the bulb lights up; you can now remove the match and the bulb will stay on because its own light output is holding the transistor on. This is called "positive feedback" and in this circuit will provide an amusing party trick—especially if assembled to look like a candle.

A bit of practice at "snuffing" the candle with the fingers (actually you are breaking the light path between the bulb and the cell) will make the effect even more astounding.

Photograph of the Demo Deck set up for the Electronic Candle Experiment showing the lamp being "lit" by the light emitted from the lighter.



TEACH-IN PART 6—ERRATA

Fig. 4(b) last month shows a lead connected wrongly. The lead from the junction of R3 and the negative meter terminal should go to the negative end of VR1 (not the wiper as shown) i.e. the one connected to the battery negative.

Next month: Multivibrators. The components needed for next month in addition to those already acquired are: resistors 22 kilohm (2 off), 100 ohm (1 off); capacitors 0·1μF polyester (2 off), 500μF elect. 12V (1 off); transistors BC108 (1 off); diodes OA91 (1 off).

Ruminations

By Sensor

Not so Clever

The coal miners' strike has shown how dependent we are, in this age of high technology, on the efforts of men who work in damp, dirty and often dangerous conditions.

I find it difficult to comprehend that on one hand the semiconductor industry owes its existence to the ability to obtain and to process materials with an impurity content of less than ten parts in a thousand million, and to operate with tolerances down to one millionth of a metre, while on the other hand men have still to dig fossil trees out of the earth (albeit with mechanical assistance) so that these fossilised remains can be burnt to boil water in order to raise steam and to generate electricity! Without coal and electricity there would be no semiconductor industry; truly our idol has feet of clay!

Let There be Light

Have you heard about the old lady who telephoned the C.E.G.B. to complain that, during the power cut, the buses were passing her house with all their lights on? She also said that she could manage to get along quite well without the electricity, except for the little light in the hall, and could they please leave that one switched on.

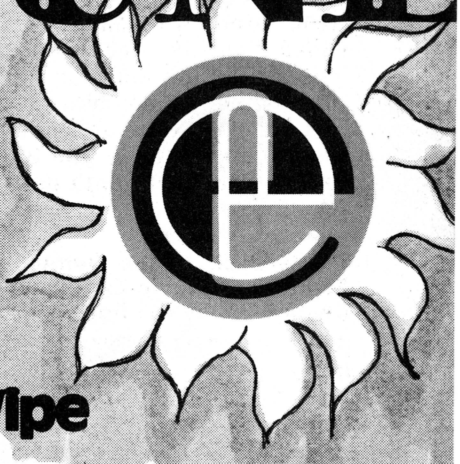
Many people must have been irritated, in the early days of the strike, to see street lights blazing all day and switched off at night, due to their electric clock switch mechanisms getting umpteen hours behind. To the electronics man the answer to this problem is so simple—a light operated switch, either using discrete components or in integrated form.

A recently introduced integrated circuit provides the necessary photo cell, level sensor and time delay all on one tiny chip of silicon and complete with lens. It could operate a relay or, better still, work into a switching transistor controlling the street lamp directly.

Some years ago, I was shown around a large generating station, where, tucked away in a dusty corner there was a cast iron box about the size of a domestic cooker. This apparatus was installed at the station about twenty five years ago and its purpose was to switch on all the electric street lamps in the town.

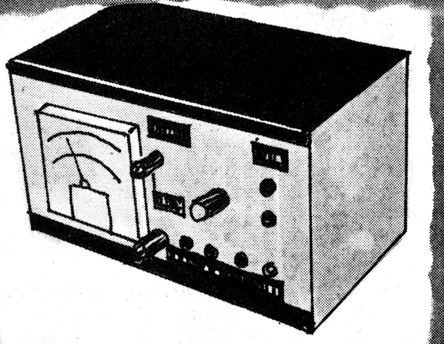
When switched on it produced a ripple which was superimposed on the mains. Sections of street lighting were grouped together under the control of master switches, spread throughout the town, which were operated by switching on the ripple equipment. The system had been in use but for some reason, unknown to my guide, had been discontinued. It would have been a blessing during February 1972.

Watch for these features in the JUNE



Wash 'n Wipe

We have produced one very popular car wiper accessory now we are going to describe another. This unit starts the wipers automatically when the washers are used, keeps the wipers going for a pre-determined time, and then turns them off. For all 6 and 12V cars fitted with washers and self parking wipers. Extremely useful with the Windscreen Wiper Control or just on its own.



Multimeter

Probably the most useful of all test equipment is a multimeter and next month we show you how to build a fairly simple one that will meet the needs of most constructors.

Light to Sound Converter

A project for those who like to experiment. This unit produces an audio tone, the frequency of which is dependent on the light level sensed by a photocell.

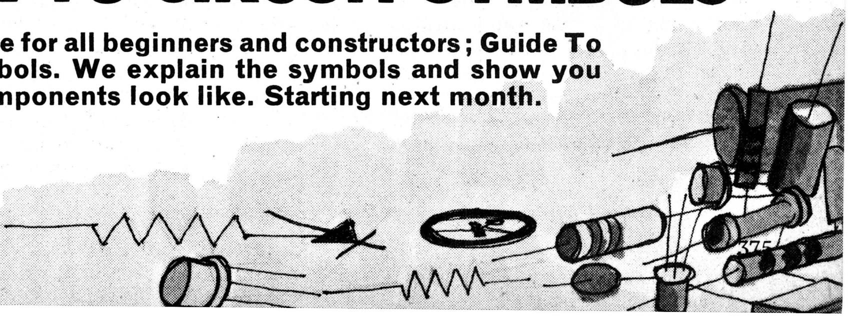
Also...

A new feature for all beginners and constructors...

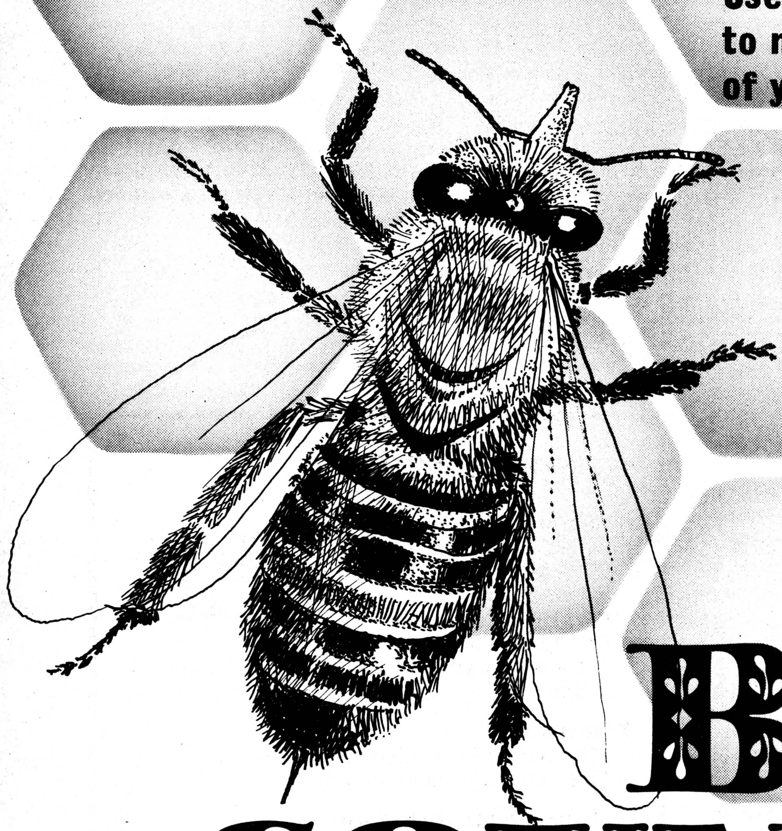
GUIDE TO CIRCUIT SYMBOLS

A new feature for all beginners and constructors; Guide To Circuit Symbols. We explain the symbols and show you what the components look like. Starting next month.

On sale Friday, May 19



Use this 'electronic eye' to monitor the busyness of your bee-hives



By G.A.Cozens

BEE COUNTER

MODERN research calls for accurate measurement and comparisons, and with this in mind this device was designed to help the bee-keeper assess the performance of his beehives more definitely, and to compare the different strains of bees under the same working conditions and so help to breed a strain which will produce the most honey under all the difficulties encountered in our changing climate without the rather nasty habit of the English bee, of attacking the bee-keeper as soon as he appears anywhere near the hive.

Approximate cost of components... £ 2·20 plus case

The Bee Counter is an instrument which records the number of bees entering the hive, and used in conjunction with other devices such as a wind speed indicator, a wind direction indicator, an air temperature thermometer, a maximum/minimum thermometer, a rain gauge and a sunshine recorder, then some degree of assessment can be made, and some basis established for the bee-breeder to work upon his main goal—lots of honey from a reasonably good tempered, busier bee.

The Bee Counter makes use of the fact that bees are highly organised in their habits, and utilises the bees sense of sight and smell. These bee "characteristics" are used in the design of the cabinet housing all the circuitry which is described later in full detail.

THE CIRCUIT

The complete circuit diagram of the counter is shown in Fig. 1 and is basically an amplifier which works as follows.

The lamp LPI, which is always "alight" when

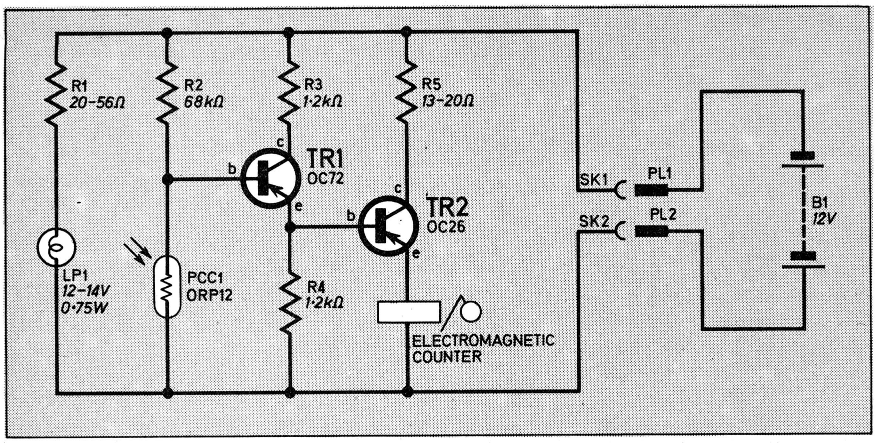


Fig. 1. The complete circuit circuit diagram of the Bee Counter.

the unit is switched on, illuminates the light dependent resistor, PCC1, and causes its resistance to be at a low value, about 100 ohms.

The l.d.r. and R2 form a potential divider circuit and under "illuminated conditions" of the l.d.r., a positive voltage with respect to the emitter, is applied to the base of TR1 causing it to be in a conducting state.

With TR1 conducting, a negative voltage is applied to TR2 base with respect to the emitter and consequently TR2 is "off" (not conducting).

When the light path between LP1 and PCC1 is broken, the resistance of PCC1 increases considerably (to about 100 kilohm for complete "blackout"). This causes the potential at TR1 base to go negative and turns it "off". This state of TR1 causes the voltage applied to the base of TR2 to go more positive and causes it to switch "on" i.e. conduct—current flows through TR2.

When current flows through the emitter leg of TR2 containing the relay coil in the counter, the relay is energised.

When the light to PCC1 is restored, TR2 switches "off" and the counter is de-energised and springs back to its off position and in doing so mechanically adds "one" to the counter readout.

The arrangement of LP1 and PCC1 in the case is so devised that the bee, on entering the hive, breaks the light path between these devices and its entry is thus recorded.

The 13-20 ohm 3 watt resistor, R5, in the collector circuit of the power transistor, TR2, is to prevent damage to the counter or the transistor if the entrance passage to the hive should become blocked, as once happened in the prototype when a drone got stuck in the narrow part.

A heavy duty battery is required to operate the Bee Counter since current drain is substantial —250 mA when TR2 is "off" and 400 mA when TR2 is "on" at 12V. A car battery is therefore recommended to supply the power. The cost of this battery is not included in approximate cost.

The voltage is fairly critical as it must be sufficient to operate the counter, but not high enough to cause overheating of TR2 or the counter coil in the event of the passage being blocked for long.

If the apparatus is disconnected every night the battery will last at least a week on one charge.

Components....

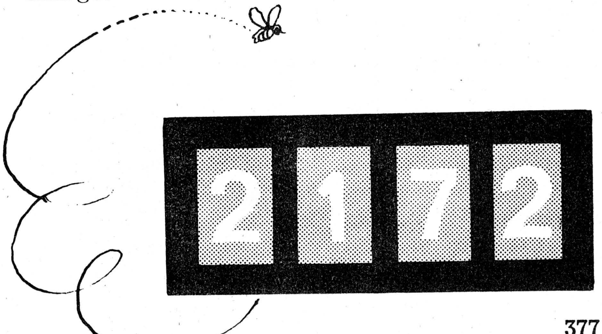
SEE SHOP TALK

Resistors
R1 20–56Ω 3 watt
R2 68kΩ
R3 1·2kΩ
R4 1·2kΩ
R5 13–20Ω 3 watt
All ½ watt carbon ± 10% unless otherwise stated

Transistors
TR1 OC72 (or similar) germanium *pnp*
TR2 OC26 germanium *pnp*

Light Dependent Resistor
PCCI ORP12

Micellaneous
LP1 12-14V 0·75W bulb and holder
PL1, PL2 Wander plugs, 1 red 1 black (2 off)
SK1, SK2 Sockets to suit plugs PL1, PL2
B1 12V battery—heavy duty rechargeable type (Not accounted for in cost box.)
Counter: Post Office type 14C 4·2Ω 4 figure readout. Cedar wood, Perspex and adhesive, Paxolin, wood screws, 4 B.A. nut and bolt, wood glue.



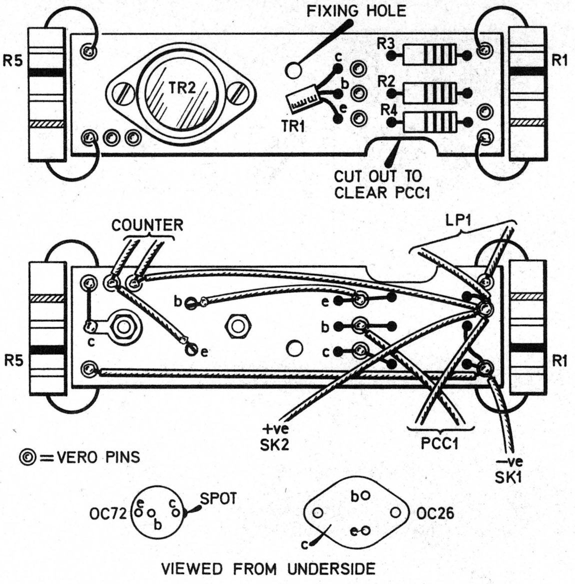


Fig. 2. The layout of the components on both sides of the Paxolin board. Veropins are used for attachment.

Variations in performance can be dealt with in several ways. The lamp should be bright enough to turn off the amplifier, but not any brighter than necessary. This is best adjusted by altering the series resistor R1, which may be increased to as high as 56 ohms.

Also, the size of the light hole can be varied, or a part of the l.d.r. painted over so that it has less area exposed, until the instrument is sufficiently sensitive, but positive in its action.

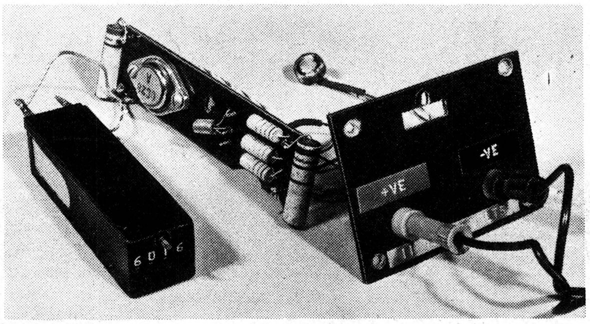
THE COUNTER

The electromagnetic counter used is a Post Office type. It has a four digit readout and can thus count up to 9,999. The maximum count rate is ten per second.

COMPONENT WIRING

Most of the components of Fig. 1 are mounted on a piece of Paxolin size $4\frac{1}{2} \times 1\frac{1}{4}$ inches with a cut-out as shown along one side to accommodate the light dependent resistor, PCC1.

Both sides of the board containing the components are shown in Fig. 2.



Veropins are used for mounting the components in position and small holes should be drilled where indicated to accommodate these pins.

Three more small holes of the same size should be drilled to take the leads of TR1 as shown.

Drill the component board fixing hole and the four holes for transistor TR2; (see reverse side of component board Fig. 2); $\frac{1}{8}$in. diameter holes will do for all five holes.

Begin assembly by pushing in all the Veropins and then attach TR2 to the board using two small nuts and bolts.

The connection to the collector of TR2 is via its casing, so a solder tag should be attached to one of the securing bolts to enable this connection.

Attach and solder all the components, link wires and flying leads as detailed in Fig. 2 making sure a heat shunt is used when soldering in TR1, which incidently should be the last component connected.

The l.d.r. should be attached to the board via 6in. long flexible leads.

The flying leads to the counter should be about 4in. long.

The two wander sockets used for battery connection to the counter, are attached to the end of the case which is made from a piece of Paxolin, dimensions are given in Fig. 3.

The connection wires from the wander sockets to the component board should be about 4in. long.

Connection to the battery is made via two wander plugs and a length of twin flex.

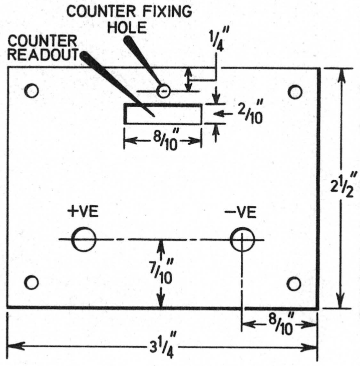
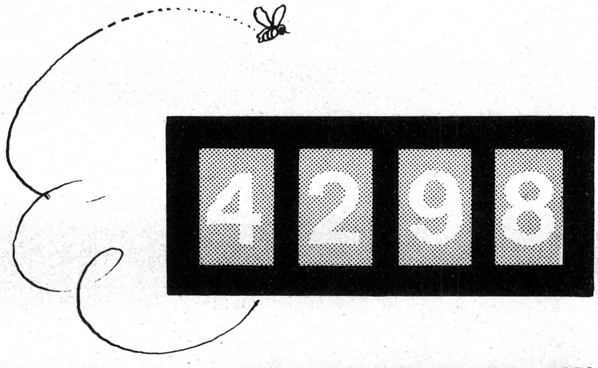


Fig. 3. Dimensions of the end made from Paxolin to accommodate the wander sockets for battery connection, and counter readout.



BEE COUNTER

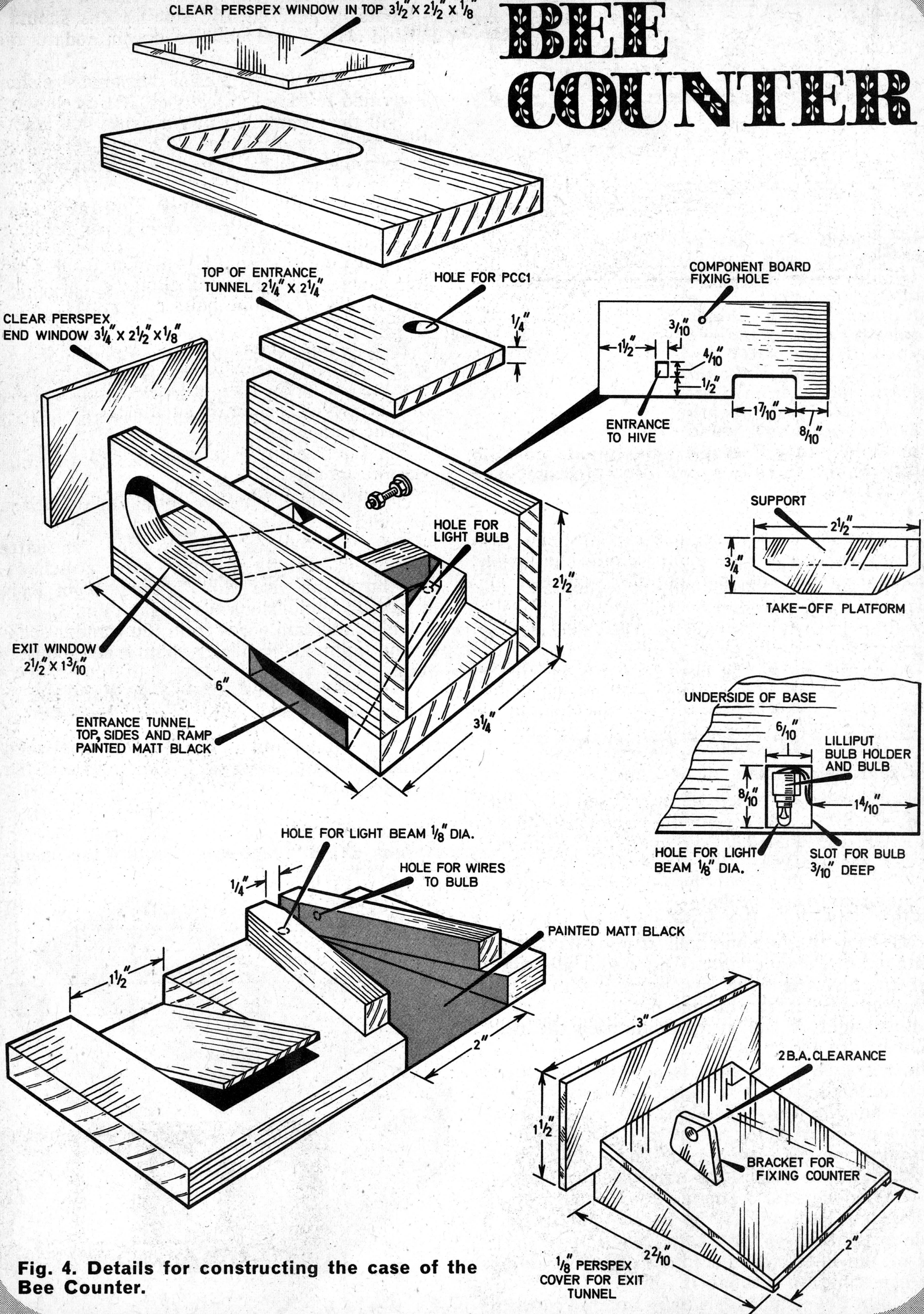


Fig. 4. Details for constructing the case of the Bee Counter.

A photograph of the prototype with top and tunnel lid (which holds PCC1 in position) removed. The photograph clearly shows the entrance and exit tunnels (labelled IN and OUT respectively). The take-off platform, made from Perspex, is located just beneath the exit cut-out, and is glued in position with Perspex adhesive.

EXIT AND ENTRANCE GEOMETRY

As said before, this device and its design utilises the bees' senses of smell and sight. From inside the hive, the exit from the hive appears as a bright opening to the outside world and so the exit path through the instrument must be a tunnel with transparent sides and top to allow this condition to be fulfilled.

In the instrument this tunnel slopes upwards so that when the bee emerges, it finds itself on a platform of Perspex, about ¾in. wide, situated above the hive base, and flies away.

When it returns, it will land on the hive base (landing/alighting board) and walk towards the hive.

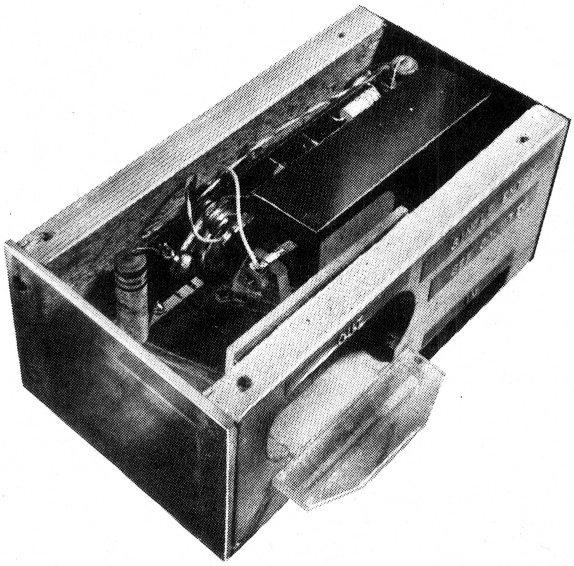
The entrance to the hive is now through the Bee Counter which is a tunnel painted matt black; when the bee walks along the front of the instrument and reaches this tunnel it will enter.

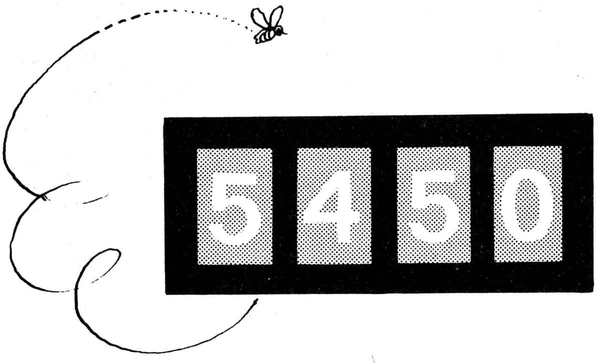
On entering, the tunnel becomes narrower and at the same time slopes upwards until it is just wide enough for a single bee to pass.

There is a lamp under the narrow part, with a hole in the floor of the tunnel, made up to the level of the floor with Perspex cement so that light can shine up through it.

The light dependent resistor is situated in the roof of the tunnel and as the bee walks between this and the lamp, the light beam is cut and the circuit activated.

Positions of the "electronics" within the case.





CONSTRUCTION OF CASE

Cedar wood should be used to construct the case as this material will be readily acceptable to the bees.

Cedar wood will also withstand the weather without the need for painting but it is well to remember that if the counter is to be used in exposed outdoor conditions, weather protection becomes an important consideration, whereas in laboratory conditions it is not so.

The best compromise for an outdoor installation is a shelter which will keep off the rain.

First of all make all the wooden parts of the case as detailed in Fig. 4.

Now solder the two thin flexible covered wires to the bulb holder tags and screw in the bulb. These wires are led out through the top of the base and the bulb assembly is glued in position.

It is not likely that the bulb will need replacement because it is "under run" and there is a 20 ohm resistor (R1) in series with the bulb which reduces the light and heat dissipated in the bulb.

When the glue has set, fill up the light hole with Perspex cement so that it comes flush with the passage floor.

Glue down the two sides of the tunnel so that the width of the narrowest region is $\frac{1}{4}$in. Paint the tunnel top, bottom and sides a matt black.

The light dependent resistor should be a push fit into a hole in the tunnel roof.

Glue and screw the front and back to the base and glue the exit ramp in position. Drop the tunnel roof into position indicated. The other parts of the case are made from Perspex and their dimensions are given in Fig. 4.

With these made we can proceed with the assembly.

ASSEMBLY

Begin by screwing the Perspex side and top windows in position as indicated. Glue the Perspex platform to the front and place the Perspex exit guide in position.

Now solder the two wires from the bulb holder to the component board as detailed in Fig. 2, push the l.d.r. in position and then attach the board to the back of the case by means of a 4 B.A. nut and bolt. This bolt should be countersunk into the back so the back is flush with the front of the hive. If there is a gap here, the bees will try to go in or out through the smallest crevice.

Attach the wander sockets to the Paxolin side and solder to the appropriate flying leads from the component board. Next screw the Paxolin side to the case.

When the flying leads to the counter have been connected, fit the counter into its locating holes, (one end in the Paxolin and the other in the bracket on top of the Perspex exit guide) and secure with nuts. The counter digits should be visible through the slot in the Paxolin side.

Screw the top on and the unit is complete.

CAPACITY AND POSITION OF CASE

The single entry counter (as this is) is only suitable for a three or four frame hive, since with a full scale hive the returning bees would sometimes overload the tunnel capacity.

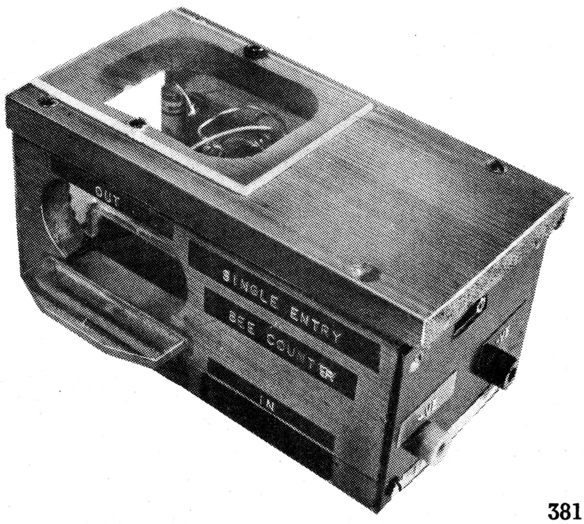
The maximum a single entry counter can handle is about 60 per minute.

For a full scale hive a three entry counter is necessary. This means the entry tunnel is divided into three passages, each with its own light beam arrangement, amplifier and counter.

Whereas the single entry model is only $6\frac{1}{4}$in. wide, which is about right for most observation hives, it is better to make the three entry model $16\frac{1}{2}$in. wide so that it takes up the whole width of a Standard National hive.

When the counter is put in front of the hive the hive should be moved back by a distance equal to the depth of the Bee Counter, in this case $3\frac{1}{4}$in. so that the point of entry is exactly as it was without the counter.

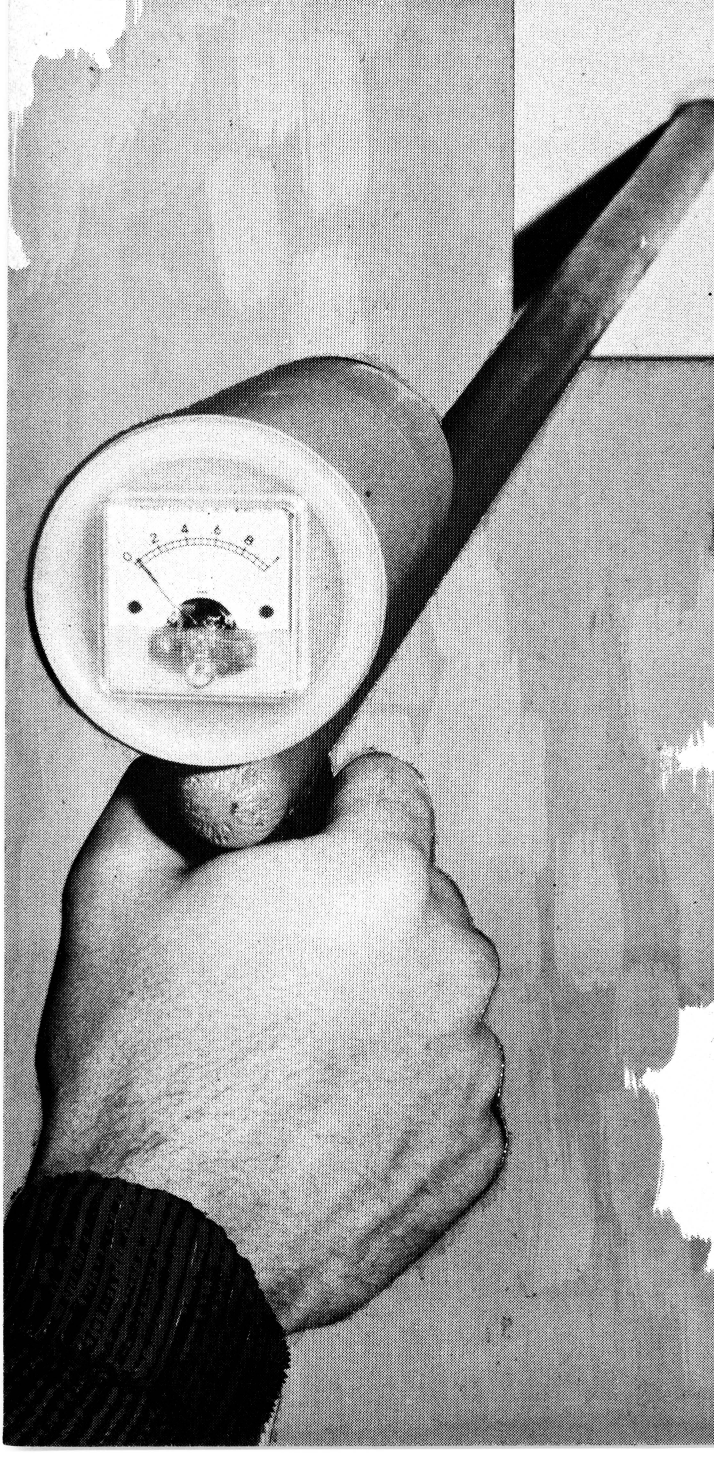
When this is done the bees will soon get used to the new conditions and will be using the exit and entry passages without any confusion. ▣



METAL

A simple, easy to construct self—contained locator giving a meter indication of buried metal.

By D. Bollen



Approximate cost of components . . . £4·00 plus case

THE metal locator described in this article was designed for simplicity and ease of operation. A single transistor circuit is used to give a clear meter indication of the presence of buried metal without the need for headphones or a nearby portable radio as used by some locators. Under typical operating conditions the instrument will detect a 2p coin at a depth of about 1 inch.

CIRCUIT OPERATION

The complete circuit of the metal locator is shown in Fig. 1. Transistor TR1 acts as a common base oscillator with positive feedback between collector and emitter controlled by trimmer C4. Search coil inductor L1 is tuned by C2 to give an oscillation frequency of 100kHz.

When the circuit is functioning, L1 will induce eddy currents in nearby metal and this transfer of energy causes an increase of TR1 emitter current. Although small, the accompanying change of d.c. voltage across R3 can be detected by a sensitive null (or zero registering) voltmeter.

In Fig. 1 the d.c. null voltmeter consists of R3, R4, R5, R6 and ME1. Capacitor C5 is included

LOCATOR

to remove unwanted a.c. from the voltmeter input, and diodes D1 and D2 protect the meter movement against overload.

At a certain setting of C4, the d.c. voltage at TR1 emitter will equal the voltage at the junction of R5 and R6 so that no current flows through ME1; this can be taken as the normal operating point for the circuit. If metal is brought close to L1, the emitter voltage of TR1 will rise by several millivolts in relation to the voltage at the junction of R5 and R6, and the meter will read.

Full scale sensitivity of the null voltmeter is around 150 millivolts. Metal Locator response is shown in Fig. 2, where meter reading is plotted against depth for three weights of metal.

CONSTRUCTION

Commence construction by cutting a piece of 0·1 inch matrix plain perforated circuit board to a size of 3·1 by 1·4 inches, and drill holes to take C4, VR1, and S1 (see Fig. 3).

Cut two brackets from a length of ½ inch aluminium angle and drill to accept the meter terminal screws and 6B.A. circuit board mounting screws.

Bolt the brackets to the circuit board, complete with solder tags, and insert all terminal pins in the positions shown in Fig. 3.

With C4, VR1, and S1 in place on the circuit board, proceed to mount and solder the remaining components in the following order; resistors, capacitors, wire links and leads, diodes and the transistor, using a heat shunt to protect the diodes and transistors while soldering them.

Obtain a plastic beaker with lid (of minimum dimensions 5 inches high by 2½ inches diameter) and cut away the centre of the lid to accept the meter MEI. Next, drill holes in the beaker for L1 leads, woodscrews, and to allow access to the circuit board controls, see Fig. 4.

When following the step-by-step instructions in Fig. 5, for making up the search coil L1, ensure that the pile windings can slide easily off the 5 inch diameter former. Short strips of insulating tape, placed sticky side out around the former, will hold the turns together and facilitate removal of the coil. Do not use Sellotape for this purpose as it is likely to damage the wire.

The metal locator frame (Fig. 4 and 6) consists of a chipboard or plywood handle, a ⅝ inch diameter dowel pole, and two s.r.b.p. or Perspex sheets for the search head. Screw and glue the handle to the pole and then glue the other end of the pole to the search head top board, this assembly can then be painted.

To complete the construction, screw the

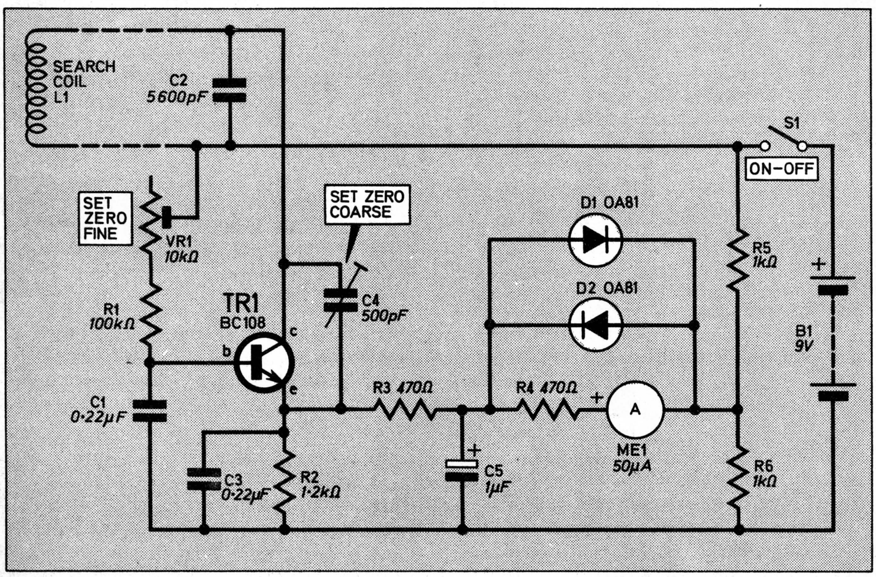


Fig. 1. Circuit diagram of the Metal Locator. The search coil L1 is mounted in the locator head and the dotted lines are the connecting wires to the circuitry.

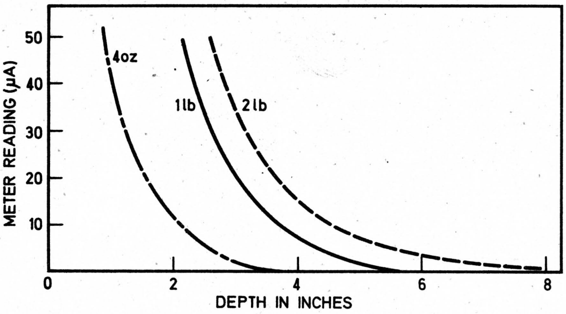


Fig. 2. Response curves of the Metal Locator.

plastic beaker to the pole opposite the handle, securely clamp the search coil between the boards, run twin leads from L1 to the beaker, and position the battery.

In the prototype, the battery was held in place behind the meter with a rubber band, as shown in the photograph, but it could equally well be fixed inside the beaker with a small clip or elastic band.

SETTING UP

Adjust VR1 to mid track, C4 to minimum capacitance (unscrewed), and switch on. The meter pointer should go beyond full scale. With the search coil well away from metal objects, screw in C4 until the meter reads somewhere between zero and full scale. Trim for a zero reading with VR1.

OPERATING LICENCE

The *Metal Locator* described in this article is designed to operate in the frequency band specified by the Ministry of Post and Telecommunications (16 to 150kHz). The circuit design of the locator should not be altered in any way that may affect the operating frequency.

A licence must be obtained before using the locator; this costs 75p for 5 years. An application form for a licence is obtainable from the Ministry of Post and Telecommunications, Waterloo Bridge House, Waterloo Road, London, S.E.1.

If the meter fails to read, or no response is obtained from adjustment of C4, check for wiring errors.

A certain amount of drift will be evident immediately after the locator has been switched on, therefore allow the circuit to settle down and then readjust C4 and VR1. Locator response can then be checked with metal weights and compared with Fig. 2.

Increased sensitivity can be achieved by reducing the value of C3 to 0·15μF, but this will enhance circuit drift to the point where frequent adjustment of VR1 is necessary. Conversely, drift and sensitivity will be reduced if C3 is increased in value.

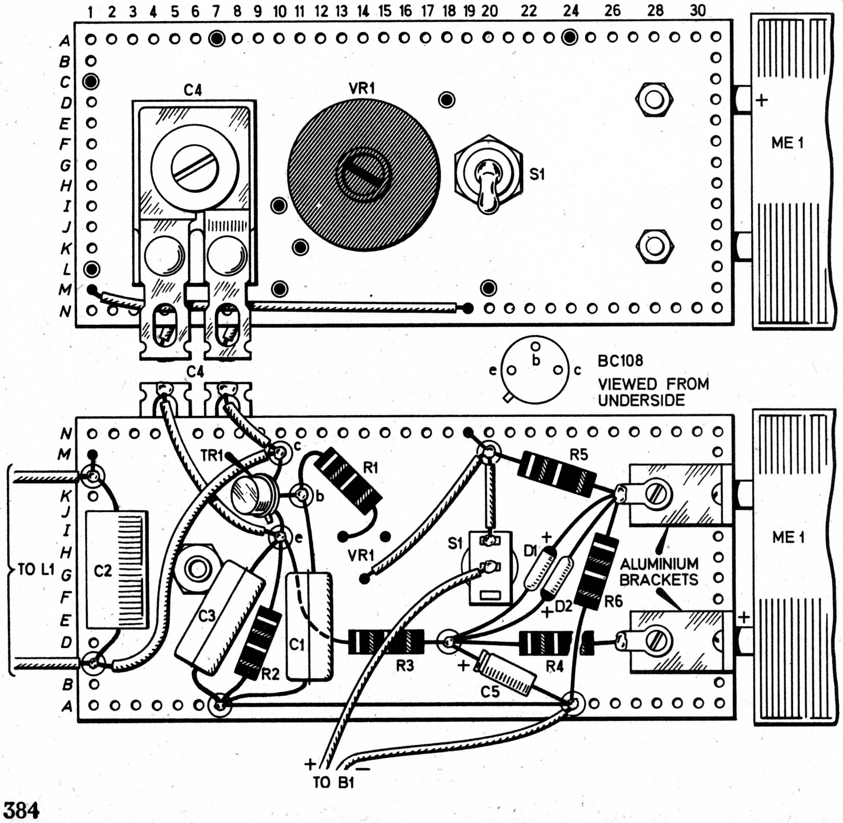


Fig. 3. Top and underside views of the circuit board and meter assembly. The circled connections represent the terminal pins used in the construction of this item. These pins are clearly indicated in the top diagram.

METAL LOCATOR

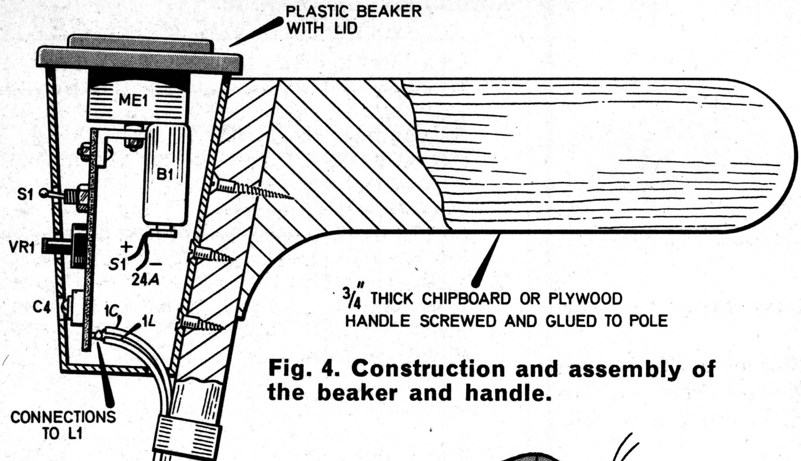
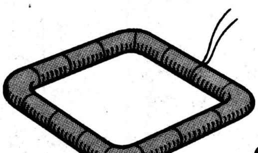
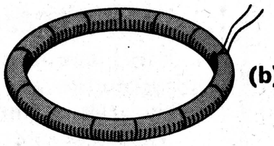


Fig. 4. Construction and assembly of the beaker and handle.



(c)

Fig. 5 (a). Coil wound on former (b) Coil removed from former and bound with tape (c) Shaped coil.



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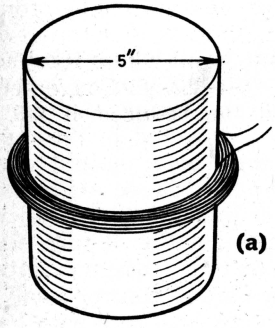

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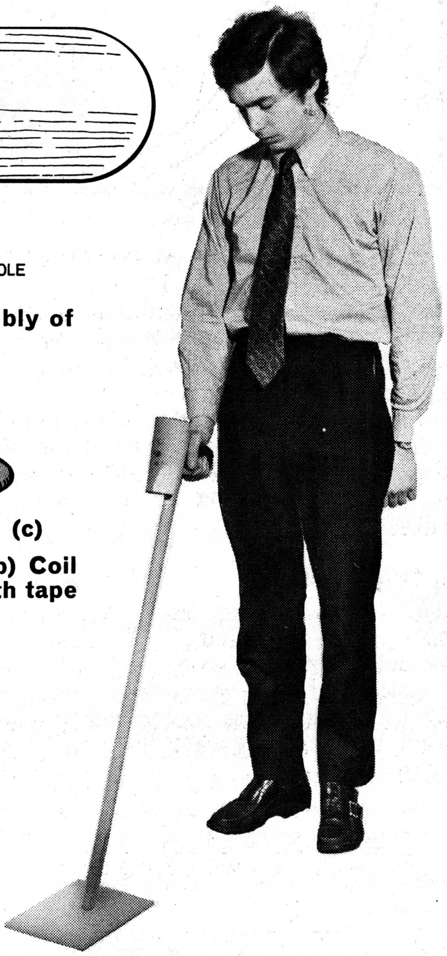


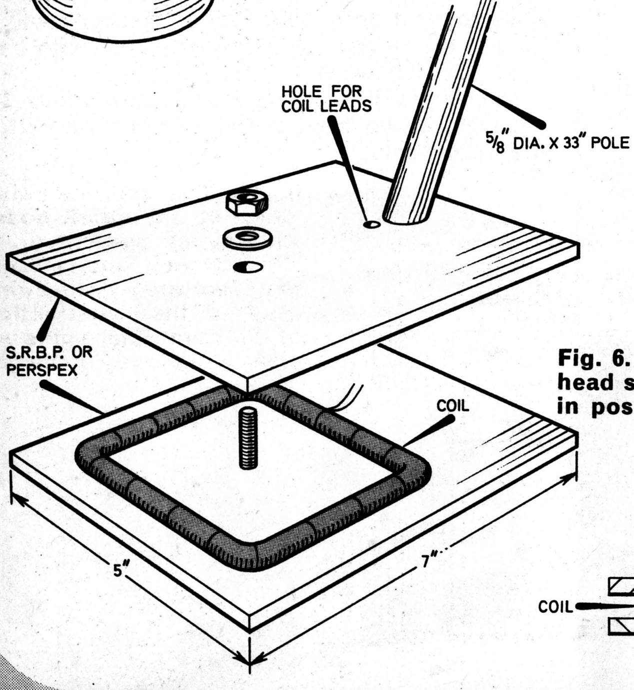
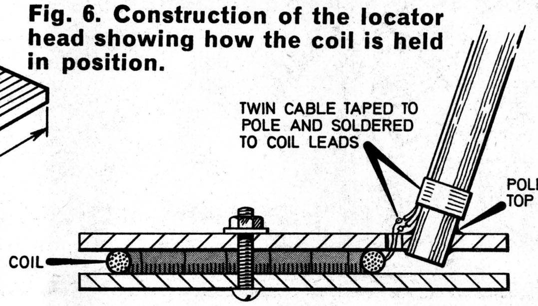


Fig. 6. Construction of the locator head showing how the coil is held in position.



Components....

SEE SHOP TALK

Resistors
R1 100kΩ
R2 1·2kΩ
R3 470Ω
R4 470Ω
R5 1kΩ
R6 1kΩ
All ± 10% ½ watt carbon.

Capacitors
C1 0·22μF polyester 250V
C2 5,600pF polystyrene
C3 0·22μF polyester 250V
C4 500pF mica compression trimmer
C5 1μF elect. 12V

Semiconductors
TR1 BC108 silicon *npn*
D1 OA81
D2 OA81

Meter
ME1 50μA f.s.d. moving coil. SEW type MR 38P

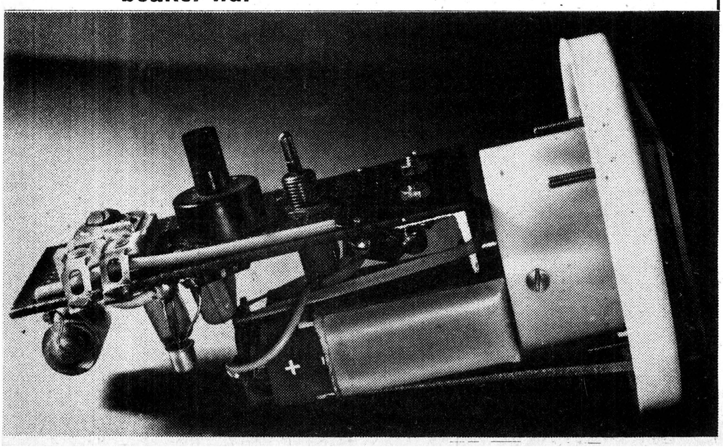
Switch
S1 S.P.S.T. sub-miniature toggle

Miscellaneous
VR1 10kΩ miniature carbon T.V. type preset
B1 PP3 battery. Circuit board 3·1 inch by 1·4 inch plain, perforated 0·1 inch matrix Veroboard and Veropins. 26 s.w.g. cotton covered or enamelled copper wire, plastic beaker (see text), connecting wire, wood and screws for assembly, ½in aluminium angle for brackets.

USE

The locator is now ready for use and can be used for beachcombing or searching the back garden or waste ground. The locator may be subjected to damp and the pole, in particular, should be painted for protection if nothing else.

Photograph showing the construction of the circuit board and meter mounted on the beaker lid.



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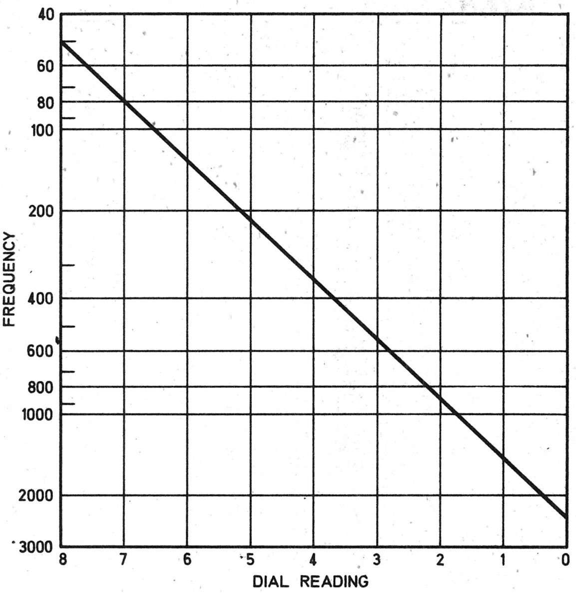


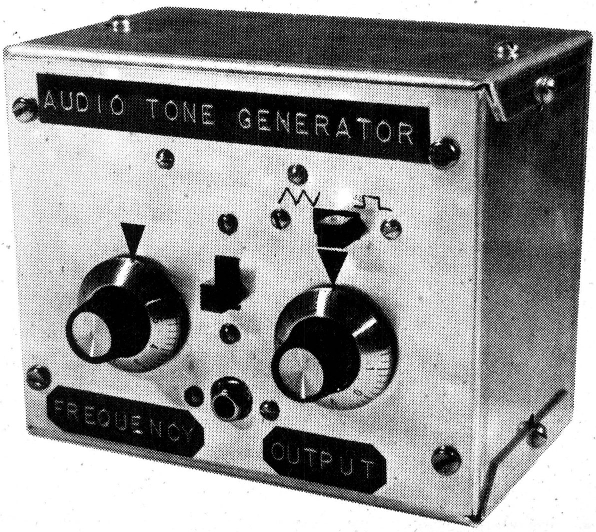
Fig. 8. Approximate output frequency for various control settings.

FINAL ASSEMBLY

Final assembly amounts to attaching the front panel to the box frame with self tapping screws, fitting the battery inside and fitting rear panel.

The generator can be connected to the input of any amplifier but the signal output level should be adjusted in accordance with that required by the amplifier input. To comply with the calibration chart given in Fig. 8 turn VR1 fully anti-clockwise and fix the frequency control knob to read zero. The output control knob is fixed in the same way i.e., to read zero with VR2 fully anti-clockwise.

The Audio Tone Generator is now ready for use and can be tried out in conjunction with a tape recorder.



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2G302	20p	2N3405	45p	40311	35p	BCY30	27½p	BSX60	82½p	NKT401	87½p
2G303	20p	2N3414	22½p	40312	47½p	BCY31	30p	BSX61	62½p	NKT402	90p
2G306	42½p	2N3415	22½p	40314	37½p	BCY32	50p	BSX76	22½p	NKT403	75p
2G308	30p	2N3416	37½p	40320	47½p	BCY33	25p	BSX77	27½p	NKT404	62½p
2G309	30p	2N3417	37½p	40323	32½p	BCY34	30p	BSX78	27½p	NKT405	75p
2G371	15p	2N3570	£1·25	40324	47½p	BCY38	40p	BSY10	27½p	NKT406	62½p
2G374	20p	2N3572	97½p	40326	37½p	BCY39	60p	BSY11	27½p	NKT451	62½p
2G381	22½p	2N3605	27½p	40329	30p	BCY40	50p	BSY24	15p	NKT452	62½p
2N404	22½p	2N3606	27½p	40344	27½p	BCY42	15p	BSY25	15p	NKT453	47½p
2N696	20p	2N3607	22½p	40347	57½p	BCY43	15p	BSY26	17½p	NKT603F	32½p
2N697	17p	2N3702	11p	40348	52½p	BCY54	32½p	BSY27	17½p	NKT613F	32½p
2N698	25p	2N3703	10p	40360	42½p	BCY58	22½p	BSY28	17½p	NKT674F	30p
2N706	12½p	2N3704	11p	40361	47½p	BCY59	22½p	BSY29	17½p	NKT677F	30p
2N705A	12½p	2N3705	10p	40362	57½p	BCY60	97½p	BSY32	25p	NKT713	25p
2N708	15p	2N3706	09p	40370	32½p	BCY70	20p	BSY36	25p	NKT781	30p
2N709	62½p	2N3707	11p	40406	57½p	BCY71	25p	BSY37	25p	NKT10419	30p
2N718	25p	2N3708	07p	40407	40p	BCY72	17½p	BSY38	22½p	NKT10439	
2N726	30p	2N3709	09p	40408	52½p	BCZ10	27½p	BSY39	22½p		37½p
2N727	30p	2N3710	09p	40410	62½p	BCZ11	42½p	BSY40	32½p	NKT10519	
2N914	17½p	2N3711	12p	40467A	57½p	BD116	£1·12½	BSY51	32½p		32½p
2N916	17½p	2N3715	£1·25	40468A	35p	BD121	65p	BSY52	32½p	NKT20329	
2N918	30p	2N3716	£1.30	40600	57½p	BD123	82½p	BSY53	37½p		47½p
2N929	22½p	2N3791	£2.06	AC107	30p	BD124	60p	BSY54	40p	NKT20339	
2N930	27½p	2N3819	35p	AC126	20p	BD131	75p	BSY56	90p		37½p
2N1090	22½p	2N3823	97½p	AC127	25p	BD132	85p	BSY78	47½p	NKT80111	
2N1091	22½p	2N3854	27½p	AC128	20p	BDY10	£1·37½	BSY79	45p		77½p
2N1131	25p	2N3854A	27½p	AC154	22½p	BDY11	£1·62½	BSY82	52½p	NKT80112	
2N1132	25p	2N3855	27½p	AC176	25p	BDY17	£1·50	BSY90	57½p		97½p
2N1302	17½p	2N3855A	30p	AC187	62½p	BDY18	£1·75	BSY95A	12½p	NKT80113	
2N1303	17½p	2N3856	30p	AC188	37½p	BDY19	£1·97½	BSW41	42½p		£1.12
2N1304	22½p	2N3856A	35p	ACY17	27½p	BDY20	£1·12½	BSW70	27½p	NKT80211	
2N1305	22½p	2N3858	25p	ACY18	25p	BDY38	97½p	C111	75p		92½p
2N1306	25p	2N3858A	30p	ACY19	25p	BDY60	£1·25	C424	27½p	NKT80212	
2N1307	25p	2N3859	27½p	ACY20	25p	BDY61	£1·25	C425	55p		92½p
2N1308	30p	2N3859A	32½p	ACY21	25p	BDY62	£1·00	C426	40p	NKT80213	
2N1309	30p	2N3860	30p	ACY22	20p	BF115	25p	C428	37½p		92½p
2N1507	17½p	2N3866	£1.50	ACY28	20p	BF117	47½p	C744	30p	NKT80214	
2N1613	25p	2N3877	40p	ACY40	20p	BF163	37½p	D16P1	37½p		92½p
2N1631	35p	2N3877A	40p	ACY41	25p	BF167	18p	D16P2	40p	NKT80215	
2N1632	30p	2N3900	37½p	ACY44	40p	BF173	19p	D16P3	37½p		92½p
2N1638	27½p	2N3900A	40p	AD140	52½p	BF177	30p	D16P4	40p	NKT80216	
2N1639	27½p	2N3901	97½p	AD149	57½p	BF178	30p	GET102	30p		92½p
2N1671B	£1·00	2N3903	35p	AD150	62½p	BF179	30p	GET113	20p	OC20	75p
2N1711	25p	2N3904	35p	AD161	37½p	BF180	35p	GET114	20p	OC22	50p
2N1889	32½p	2N3905	37½p	AD162	37½p	BF181	32½p	GET118	20p	OC23	60p
2N1893	37½p	2N3906	37½p	AF106	42½p	BF184	25p	GET119	20p	OC24	60p
2N2147	82½p	2N4058	17½p	AF114	25p	BF185	42½p	GET120	52½p	OC25	50p
2N2148	57½p	2N4059	10p	AF115	25p	BF194	17½p	GET873	12½p	OC26	27½p
2N2160	57½p	2N4060	12½p	AF116	25p	BF195	15p	GET880	30p	OC28	62½p
2N2193	40p	2N4061	12½p	AF117	25p	BF196	42½p	GET887	20p	OC29	62½p
2N2193A	42½p	2N4062	12½p	AF118	62½p	BF197	42½p	GET889	22½p	OC35	50p
2N2194A	30p	2N4244	47½p	AF119	20p	BF198	42½p	GET890	22½p	OC36	62½p
2N2217	27½p	2N4285	17½p	AF124	22½p	BF200	52½p	GET896	22½p	OC41	22½p
2N2218	23p	2N4286	17½p	AF125	20p	BF224	14p	GET897	22½p	OC42	25p
2N2219	23p	2N4287	17½p	AF126	20p	BF225	19p	GET898	22½p	OC44	20p
2N2220	25p	2N4288	17½p	AF127	17½p	BF237	23p	MJ400	£1·07½	OC45	12½p
2N2221	25p	2N4289	17½p	AF139	37½p	BF238	23p	MJ420	£1·12½	OC46	15p
2N2222	30p	2N4290	17½p	AF178	42½p	BF244	23p	MJ421	£1.12½	OC70	15p
2N2270	47½p	2N4291	17½p	AF179	72½p	BFW61	47½p	MJ430	£1·02½	OC71	12½p
2N2297	30p	2N4292	12½p	AF180	52½p	BFX12	22½p	MJ440	95p	OC72	12½p
2N2368	17½p	2N4303	47½p	AF181	42½p	BFX13	22½p	MJ480	97½p	OC74	32½p
2N2369	17½p	2N5027	52½p	AF239	42½p	BFX29	30p	MJ481	£1·25	OC75	22½p
2N2369A	17½p	2N5028	57½p	AF279	47½p	BFX30	30p	MJ490	£1·00	OC76	22½p
2N2410	42½p	2N5029	47½p	AF280	62½p	BFX42	37½p	MJ491	£1·37½	OC77	30p
2N2483	27½p	2N5030	42½p	AF211	32½p	BFX44	37½p	MJ1800	£2·17½	OC81	20p
2N2484	32½p	2N5172	12½p	ASY26	25p	BFX68	67½p	MJE340	62½p	OC81D	22½p
2N2539	22½p	2N5174	52½p	ASY27	37½p	BFX84	25p	MJE520	60p	OC83	25p
2N2540	22½p	2N5175	52½p	ASY28	27½p	BFX85	32½p	MJE521	73p	OC84	25p
2N2613	35p	2N5176	45p	ASY29	27½p	BFX86	25p	MPF102	42½p	OC139	32½p
2N2614	30p	2N5232A	30p	ASY36	25p	BFX87	27½p	MPF103	37½p	OC140	32½p
2N2646	52½p	2N5245	45p	ASY50	25p	BFX88	25p	MPF104	37½p	OC170	30p
2N2696	32½p	2N5246	42½p	ASY51	32½p	BFX89	62½p	MPF105	37½p	OC171	30p
2N2711	25p	2N5249	67½p	ASY54	25p	BFX93A	70p	MPS3638	32½p	OC200	40p
2N2712	25p	2N5265	£3·25	ASY86	32½p	BFY10	32½p	NKT0013	47½p	OC201	60p
2N2713	27½p	2N5266	£2·75	AU103	£1·25	BFY11	42½p	NKT124	42½p	OC202	75p
2N2714	30p	2N5267	£2·62½	ASZ21	42½p	BFY17	22½p	NKT125	27½p	OC203	42½p
2N2865	62½p	2N5305	37½p	BC107	10p	BFY18	32½p	NKT126	27½p	OC204	42½p
2N2904	30p	2N5306	40p	BC108	10p	BFY19	32½p	NKT128	27½p	OC205	90p
2N2904A	32½p	2N5307	37½p	BC109	10p	BFY20	£1·60	NKT135	27½p	OC207	75p
2N2905	37½p	2N5308	37½p	BC113	15p	BFY21	42½p	NKT137	32½p	OCP71	42½p
2N2905A	40p	2N5309	62½p	BC115	15p	BFY24	45p	NKT210	30p	ORP12	50p
2N2906	25p	2N5310	42½p	BC116A	15p	BFY25	25p	NKT211	30p	ORP61	50p
2N2906A	27½p	2N5354	27½p	BC118	10p	BFY26	20p	NKT212	30p	P346A	22½p
2N2907	30p	2N5355	27½p	BC121	20p	BFY29	50p	NKT213	30p	TIS34	62½p
2N2923	15p	2N5356	32½p	BC122	20p	BFY30	50p	NKT214	22½p	TIS43	27p
2N2924	15p	2N5365	47½p	BC125	20p	BFY41	50p	NKT215	22½p	TIS44	10p
2N2925	15p	2N5366	32½p	BC126	20p	BFY43	62½p	NKT216	37½p	TIS45	10p
2N2926		2N5367	57½p	BC140	37½p	BFY50	23p	NKT217	42½p	TIS46	11p
Green	14p	2N5457	37½p	BC147	10p	BFY51	20p	NKT219	30p	TIS47	11p
Yellow	12½p	2S005	75p	BC148	10p	BFY52	23p	NKT223	27½p	TIS48	12½p
Orange	12½p	2S020	£2·00	BC149	12p	BFY53	17½p	NKT224	25p	TIS49	12½p
2N3011	30p	2S102	50p	BC152	17½p	BFY56A	57½p	NKT225	22½p	TIS50	17½p
2N3014	32½p	2S103	25p	BC157	20p	BFY75	30p	NKT229	30p	TIS51	12½p
2N3053	18p	2S104	25p	BC158	11p	BFY76	42½p	NKT237	35p	TIS52	12½p
2N3054	46p	2S501	32½p	BC159	12p	BFY77	57½p	NKT238	25p	TIS53	22½p
2N3055	62p	2S502	35p	BC160	62½p	BFY90	67½p	NKT240	27½p	TIS60	22½p
2N3133	30p	2S503	27½p	BC167	11p	BFW58	27½p	NKT241	27½p	TIS61	25p
2N3134	30p	3N83	40p	BC168B	10p	BFW59	25p	NKT242	20p	TIS62	27½p
2N3135	25p	3N128	70p	BC168C	11p	BFW60	25p	NKT243	62½p	TIP29A	50p
2N3136	25p	3N140	77½p	BC169B	11p	BPX25	£1·85	NKT244	17½p	TIP30A	60p
2N3390	25p	3N141	72½p	BC169C	11p	BPX29	£1·80	NKT245	20p	TIP31A	62½p
2N3391	20p	3N142	55p	BC170	12½p	BPY10	£1·45	NKT261	20p	TIP32A	75p
2N3391A	30p	3N143	67½p	BC171	15p	BRY39	37½p	NKT262	30p	TIP33A	
2N3392	17½p	3N152	87½p	BC172	15p	BSX19	17½p	NKT264	20p		£1·02½p
2N3393	15p	R.C.A.	52½p	BC175	22½p	BSX20	17½p	NKT271	20p	TIP34A	£2·05
2N3394	15p	40050	55p	BC182	10p	BSX21	37½p	NKT272	20p	TIP35A	£2·90
2N3402	22½p	40251	32½p	BC183	09p	BSX26	45p	NKT274	20p	TIP36A	£3·68
2N3403	22½p	40309	32½p	BC184	11p	BSX27	47½p	NKT275	20p		

Post & Packing 13p per order. Europe 25p. Commonwealth (Air) 65p (MIN.)
Matching charge (audio transistors only) 15p extra per pair.
Prices subject to alteration without prior notice.

TTL. LOGIC I.C. NEW PRICES

	1-11 £p	12-24 £p		1-11 £p	12-24 £p		1-11 £p	12-24 £p
SN7400	0·20	0·18	SN7433	0·80	0·75	SN7472	0·32	0·30
SN7401	0·20	0·18	SN7437	0·64	0·06	SN7473	0·43	0·41
SN7402	0·20	0·18	SN7438	0·64	0·60	SN7474	0·43	0·41
SN7403	0·20	0·18	SN7440	0·23	0·21	SN7475	0·45	0·44
SN7405	0·20	0·18	SN7441AN	0·87	0·83	SN7476	0·45	0·44
SN7406	0·80	0·75	SN7442	0·85	0·81	SN7480	0·70	0·65
SN7407	0·80	0·75	SN7443	2·86	2·70	SN7481	1·40	1·38
SN7408	0·20	0·18	SN7444	2·86	2·70	SN7482	0·87	0·82
SN7409	0·20	0·18	SN7445	2·50	2·40	SN7483	0·87	0·82
SN7410	0·20	0·18	SN7446	1·00	0·95	SN7484	2·00	1·85
SN7411	0·23	0·21	SN7447	1·00	0·95	SN7485	3·62	3·40
SN7412	0·48	0·46	SN7448	1·00	0·95	SN7486	0·33	0·30
SN7413	0·40	0·38	SN7449	1·00	0·95	SN7490	0·87	0·84
SN7420	0·20	0·18	SN7450	0·20	0·18	SN7491AN	1·21	1·10
SN7423	0·51	0·47	SN7451	0·20	0·18	SN7492	0·87	0·84
SN7427	0·48	0·45	SN7453	0·20	0·18	SN7493	0·87	0·84
SN7428	0·80	0·75	SN7454	0·20	0·18	SN7494	0·87	0·84
SN7430	0·23	0·15	SN7460	0·20	0·18	SN7495	0·87	0·84
SN7432	0·48	0·42	SN7470	0·40	0·38	SN7496	0·87	0·84

MULLARD SUB-MIN ELECTROLYTIC

C425 range axial lead **6p each**
Values: (μF/V): 0·64/64; 1/40; 1·6/25; 2·5/16; 2·5/64; 4/10; 4/40; 6·4/6·4; 6·4/25; 8/40; 10/16; 10/64; 12·5/25; 16/40; 20/16; 20/64; 25/6·4; 25/25; 32/10; 32/40; 32/64; 40/16; 50/6·4; 50/25; 50/40; 64/10; 80/2·5; 80/16; 80/25; 100/6·4; 125/10; 125/16; 200/10; 320/6·4.

SILICON RECTIFIERS

PIV	50	100	200	400	600	800	1000	1200
1A	8p	9p	10p	11p	12p	15p	20p	—
3A	15p	—	—	22½p	—	30p	—	—
6A	—	—	25p	30p	32½p	35p	—	—
10A	30p	35p	40p	47p	56p	66p	75p	—
15A	36p	45p	48p	55p	65p	75p	87p	—
35A	70p	80p	90p	£1·00	£1·40	£1·70	£2·75	—

1 amp and 3 amp are plastic encapsulation.

DIODES & RECTIFIERS

IN34A	10p	AA119	7p	BAX16	12½p	FST3/4	22½p
IN914	7p	AA129	15p	BAY18	17½p	OA5	17p
IN916	7p	AAZ13	12p	BAY31	7p	OA10	20p
IN4007	20p	AAZ15	12p	BAY38	25p	OA9	10p
IS44	7p	AAZ17	10p	BY100	15p	OA47	8p
IS113	15p	BA100	15p	BY103	22p	OA70	7p
IS120	12p	BA102	25p	BY122	47½p	OA73	10p
IS121	14p	BA110	25p	BY124	15p	OA79	7p
IS130	8p	BA114	15p	BY126	15p	OA81	8p
IS131	10p	BA115	7p	BY127	17p	OA85	10p
IS132	12p	BA141	17p	BY164	57p	OA90	7p
IS920	7p	BA142	17p	BYX10	22p	OA91	7p
IS922	8p	BA144	12p	BYZ10	35p	OA95	7p
IS923	12p	BA145	17p	BYZ11	32p	OA200	7p
IS940	5p	BA154	12p	BYZ12	30p	OA202	10p
		BAX13	5p	BYZ13	25p	TIV307	50p

"SCORPIO" CAP DISCHARGE IGNITION SYSTEM
(As printed in P.E. Nov. '71). Complete kit £10·00 P. & P. 50p.

BRIDGE RECTIFIERS

A.	PIV		A.	PIV	
1	100	37p	4	50	60p
1.4	140	57p	4	100	70p
2	50	32p	4	400	80p
2	200	41p	6	50	62p
2	400	46p	6	200	80p
			6	400	£1·10

THYRISTORS (SCR)

PIV	50	100	200	300	400
1A	25p	27½p	37½p	40p	47½p
4A	40p	45p	55p	—	60p
7A	82p	87p	92p	—	£1·12p

TIC47 0.6 amp. 200 PIV **55p.**
Also 12 amp. 100 PIV **75p**
2N3525 at **£1.12½p**

VEROBOARD

	0·15 Matrix	0·1 Matrix
2½ × 3¾in	17p	23p
2½ × 5in	25p	25p
3¾ × 3¾in	25p	25p
3¾ × 5in	30p	29p
5 × 17in (Plain)	83p	—

Vero Pins (Bag of 36) **20p**
Vero Cutter **45p**
Pin Insertion Tools (·1 and ·15 matrix) at **55p.**

OPTOELECTRONICS
MINITRON 3015F SEVEN SEGMENT INDICATOR £2·00
TIL 209 LIGHT EMITTING DIODE (RED) 0·35p.
B9900 PHOTORESISTOR 38p

RESISTORS

Carbon Film
⅛ watt 5%, **1p.** ⅛W, 1W & 2W E24 Series.
¼ watt 5%, **1p.**
½ watt 5%, **1½p.**
½ w 2% M/O **4p.**
1 watt 10%, **2½p.** ¼W & ½W E12 Series.
2 watt 10%, **6p.**

MULLARD C280 M/FOIL CAPACITORS

0·01, 0·022, 0·033, 0·047 **3p** each
0·068, 0·10 .. .. **4p** each
0.15, 0·22, 0·33 .. .. **5p** each
0·47 .. .. .. **9p**
0·68 .. .. .. **11p**
1μF **14p**
1·5μF **21p**
2·2μF **25p**

WIRE-WOUND RESISTORS
2·5 watt 5% (up to 270 ohms only). **7p**
5 watts 5% (up to 8·2kΩ only), **9p**
10 watt 5% (up to 25kΩ only), **10p**

POTENTIOMETERS

Carbon:
Log. and Lin., less switch, **16p.**
Log. and Lin., with switch, **25p.**
Wire-wound Pots (3W), **38p.**
Twin Ganged Stereo Pots, Log. and Lin., **40p.**

PRESETS (CARBON)

0·1 Watt **6p** VERTICAL
0·2 Watt **6p** OR
0·3 Watt **7½p** HORIZONTAL

THERMISTORS

R53 (STC) **£1·27½** VA3705 **95p**
K151 (1k) **12p** VA1077 **20p**
Mullard Thermistors also in stock. Please enquire.

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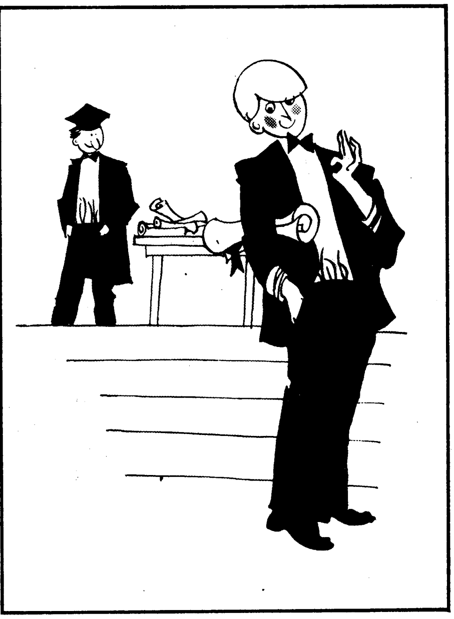


Last month we posed some problems under the heading *Teach in Half-Term Test.* We will now answer those problems and try to show how we arrived at the answers. If you have got some of them wrong do not worry, just try and follow our explanation and see where you went wrong.

(1) They flow from negative to positive in reality. Although we assume that conventional current flows from positive to negative the actual electrons flow from negative to positive.

(2) (b) μA (microamps), (e) A (amps)

(3) 22 volts. $V = IR$ hence $V = 0{\cdot}01 \times 2{\cdot}2 \times 1{,}000 = 22V$

(4) It does not matter. All the resistor does is to limit the current; this can be done at any point around the circuit.

(5) 2·8mA. Total resistance is $2{\cdot}2k\Omega + 1k\Omega = 3{\cdot}2k\Omega$.

Current flow $I = \frac{V}{R} = \frac{9}{3{\cdot}2 \times 1{,}000} = 2{\cdot}8 \div 1{,}000A = 2{\cdot}8mA$

(6) R1 and R3 ½W, R2 1W. Total circuit resistance

$$R_T = R1 + \frac{R2 \times R3}{R2 + R3} = 10 + 33{\cdot}3 = 43{\cdot}3\Omega.$$

$$\text{Total current } I = \frac{V}{R} = \frac{9}{43{\cdot}3} = 0{\cdot}21A$$

Dissipation of $R1 = I^2R = 0{\cdot}21 \times 0{\cdot}21 \times 10 = 0{\cdot}44W$. The nearest commercial rating is ½W. Next calculate the voltage drop across R2 and R3 together $V = IR = 0{\cdot}21 \times 33{\cdot}3 = 7V$.

We know that $W = I^2R$, but $I = \frac{V}{R}$ therefore

$W = \frac{V}{R} \times \frac{V}{R} \times R$ and, cancelling $W = \frac{V^2}{R}$

$$\text{Dissipation in R2} = \frac{V^2}{R} = \frac{7 \times 7}{50} = \frac{49}{50} = 0{\cdot}98W$$

$$\text{Dissipation in R3} = \frac{V^2}{R} = \frac{49}{100} = 0{\cdot}49W$$

(7) 0·4W or 400mW. Maximum dissipation occurs when the value of VR1 equals that of R1 i.e. 50Ω. When both resistors are of equal value the voltage drop across each is half the voltage drop across both, therefore, maximum dissipation in VR1

$$= \frac{V^2}{R} = \frac{4{\cdot}5 \times 4{\cdot}5}{50} = \frac{20{\cdot}25}{50} = 0{\cdot}405W$$

(8) (a) 4·7kΩ ± 10%
(b) 22kΩ ± 5%
(c) 100kΩ ± 10%

(9) (b) 20μF 40V. In most applications using electrolytic capacitors the capacitance must be greater than a certain value; the tolerance of a normal 16μF would encompass 20μF. The important thing is that the working voltage is the same or greater.

(10) Reject it politely. He has given you a 120,000pF or 0·12μF capacitor. Check to see if he has the precise value and, if he does not, you may as well take this one, since it should be near enough to use as a substitute.

(11) C1 will charge up the fastest as it has the lowest value and is being charged through the lowest value resistor.

(12) C2 will take the longest time to charge, as it has the highest value and is being charged through the highest value resistor.

(13) Forward biassed. The conventional current flows from positive to negative and can thus flow through the diode in the direction of the arrow.

(14) 100V and 100mA. Peak reverse breakdown voltage will be the battery voltage. Since in the reversed biassed condition there is negligible current flowing R1 will not drop any voltage and the full supply voltage will appear across D1. In the forward biassed condition the diode can be assumed to be a short circuit thus only R1 can limit the current flowing hence

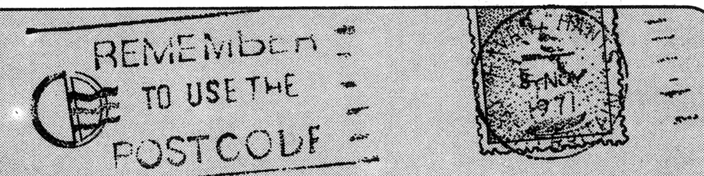
$$I = \frac{V}{R} = \frac{100}{1 \times 1{,}000} = 0{\cdot}1A \text{ or } 100mA$$

(15) (d) 100V, 150mA. Both ratings given are minimum ratings, 0·1A = 100mA.

(16) (b) 0·6V. As the diode is forward biassed the voltage would be 0·6V. There is always a voltage drop of approximately 600mV across silicon diodes due to the "knee" in the characteristic.

Well, how did you fare? If you got them all right that is excellent, if you did not the important thing is that you understand where you had difficulties. We suggest that you re-read the relevant sections of the *Teach-In* series.

We hope that you found the questions a challenge and at the same time they have opened your eyes to some calculation methods—particularly the calculation of dissipation. If you used $W = I^2R$ instead of deriving $W = \frac{V^2}{R}$ this does not matter but it may pay to look for an easier way next time.



Readers Letters

Bias Value

Having been a subscriber to *P.E.* and *P.W.* "off and on" for about 10 years I came across the January issue of EVERYDAY ELECTRONICS, which had my instant approval and now joins the rank of my other magazine's culminating in an endless and very informative pile on top the piano.

I find it is a magazine not only of theoretical enthusiasm but of great practical interest to the "everyday handyman" and certain to be a book for beginners, especially the very helpful facts "projected" by Mike Hughes, M.A.

I would hope in the future that perhaps Mr. Hughes could give reference to finding values of bias resistors, etc., needed for the satisfactory operation of different transistor parameters, and also relevant circuit operation of thyristors, unijunction and field effect transistors and other very useful flexible types of semiconductors.

Noticing other readers' troubles referring to the *Electro Laugh,* I also constructed this article and it worked first time owing to the way I adopt when working on, or constructing any project, I always check the finished article with the actual circuit diagram thus finding our little friend Q7 and P7.

Unfortunately the only earphone I had was a high impedance crystal type, but by connecting a resistor in the region of 250 ohms in parallel with it, it brought the overall impedance down to a satisfactory level with a slight reduction in volume.

J. Mason
S. Wales

We doubt if Teach-In *will be able to meet all your needs as it will finish after 12 months. However we will be publishing further series that should help.*

Another Bug

Naturally, I was quite flattered to discover that you had found my letter sufficiently interesting for inclusion in *Readers Letters* (March issue), however, I must admit that my pleasure was mixed with large helpings of disappointment and frustration due to your editing of the letter.

I am not complaining at all about the amount of space allocated to my comments—I realise you have the right to include only that which in your wisdom you decide is worthy of publication.

My complaint is that you have entirely neglected to make even a brief reference to what was after all the main point of my letter—the difficulty of obtaining items advertised in your magazine. By omitting any reference to this frustrating situation, my letter as printed is sailing under false colours—the few minor constructional queries were in fact, sorted out by trial and error once I got going. The real reason for being unable to get cracking was not so much mounting components, as actually getting hold of them!

The fact that you completely ignored my comments regarding suppliers leads me to two conclusions:

(One) That you accepted my comments to be an exaggeration of a somewhat hysterical nature, and were not a true picture of the real situation, or

(Two) That you accepted my statements as correct, but did not wish to offend your advertisers whose business you must obviously wish to retain.

With regard to the former, I feel I must now justify my remarks by quoting a few of the more deplorable examples of SERVICE, and leave you to form your own conclusions. These examples are on a separate sheet herewith enclosed.

Regarding (Two), whilst I realise that you are not to be held responsible for goods or services advertised in your columns, you do, however, have a moral responsibility to your readers. After all, it is you that place these offers before us, the readers, and if for example, I had not seen a certain item offered in your magazine, then I would have been saved the trouble and frustration that followed when the item failed to arrive, and all attempts to obtain satisfaction are largely ignored.

However, I have now found a couple of very good suppliers whose friendly, courteous, and extremely efficient service have allowed me to obtain some of the pleasure that I had hoped would be derived from my new hobby (Galleon Trading Co. and Radio Exchange Co.).

To date I have completed several very efficient radios, some from kits; also the *Astron,* a general purpose amplifier, and one or two other gadgets, and success rate so far is quite satisfactory, so the situation is not too black after all.

J. G. Richards
Sale, Cheshire

The above correspondent supplied us with details of orders placed with four different advertisers, none of which had been expediently dealt with, at the time of writing.

We have investigated all of these cases on behalf of our reader. The delays, regrettable as they are, seem to be unavoidable and can be largely attributed to the phenomenal success of this magazine's declared intention to popularise the hobby of electronics!

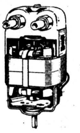
As a consequence, our advertisers are sometimes overwhelmed by a flood of orders, and delays do therefore sometimes arise. But we know all our advertisers make determined efforts to clear their back-log of orders as quickly as possible.

We, on our part, will always investigate any serious and reasonable complaints, on behalf of our readers.

Cell Life

I have just read the March issue of EVERYDAY ELECTRONICS and thoroughly appreciated the *Ruminations* by Sensor where he mentioned the tin saw and how much damage could result to a

MULTI-SPEED MOTOR



Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000; 12,000 & 15,500 r.p.m. shaft is ⅛ in. diameter 230/240v. Its speed may be further controlled with the use of our Thyrister controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price **88p** plus 23p postage and insurance.

RESETTABLE FUSE

How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at £1 per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Price only £1 each or £11 per dozen, specify 5, 10 or 15 amp—*simply fit in place of switch.*

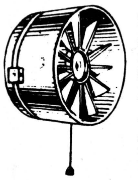
MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **83p**, plus 20p postage.

MICRO SWITCH

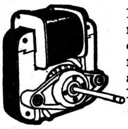
5 amp. changeover contacts, **9p** each, **£1** doz. 15 amp. Model **10p** each or **£1·05** doz.

EXTRACTOR FAN



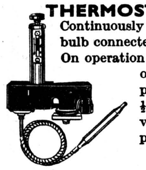
Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact, 5½″ casing with 5½″ fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets, **£2** plus 36p post and ins.

MAINS MOTOR



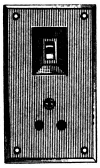
Precision made—as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at **50p.** Postage 15p for first one then 5p for each one ordered.

THERMOSTAT



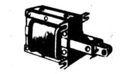
Continuously variable 30°-90° C. Has sensor bulb connected by 33in. of flexible tubing. On operation a 15 amp 250 volt switch is opened and in addition a plunger moves through approx ⅛in. This could be used to open valve on ventilator etc. **£1·50** plus 23p p. & ins.

5A 3-PIN SWITCHED SOCKETS



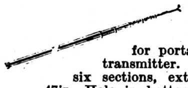
An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered switch sockets for only **50p** plus 18p post and insurance. (20 boxes post free).

MAINS OPERATED SOLENOIDS



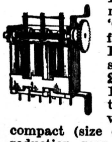
Model 772—small but powerful 1″ pull—approx. size 1½″ x 1½″ x 1½″. **60p.** **Model 400/1** ⅜″ pull. Size 2¼″ x 2″ x 1¾″. **75p.** **Model TT10** 1½″ pull. Size 3″ x 2½″ x 2½″. **£1·80** plus 20p post and insurance.

TELESCOPIC AERIAL



for portable, car radio or transmitter. Chrome plated—six sections, extends from 7¼ to 47in. Hole in bottom for 6BA screw. **38p.** KNUCKLED MODEL FOR F.M. **50p.**

3 STAGE PERMEABILITY TUNER

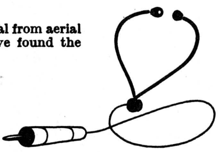


This Tuner is a precision instrument made by the famous 'Cyldon' Company for the equally famous Radiomobile Car Radio. It is a medium wave tuner (but set of longwave coils available **25p**) with a frequency coverage 1620 Kc/s–525 Kc/s and intended to operate with an I.F. value of 470 Kc/s. Extremely compact (size only 2¾ × 2 × ⅝ins. thick) with reduction gear for fine tuning. Snip price this month **50p**, with circuit of front end suitable for car radio or as a general purpose tuner for use with Amplifier. Post free.

CAPACITOR DISCHARGE CAR IGNITION

This system which has proved to be amazingly efficient. We offer kit of parts as PW circuit **£5·95** plus 20p p. & p. De-luxe model with prepared circuit board **£6·95**. When ordering please state whether for positive or negative systems.

RADIO STETHOSCOPE



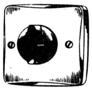
Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything — complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. **£2**—twin stethoset instead of earpiece **75p** extra post and ins. 20p.

STANDARD WAFER SWITCHES

Standard size 1⅛″ wafer—silver-plated 5-amp contact, standard ⅜″ spindle 2″ long—with locking washer and nut.

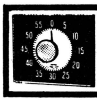
No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10way	12way
1 pole	40p	40p	40p	40p	40p	40p	40p	40p	40p
2 poles	40p	40p	40p	40p	40p	40p	40p	70p	70p
3 poles	40p	40p	40p	40p	70p	70p	70p	95p	95p
4 poles	40p	40p	40p	70p	70p	70p	70p	£1·20	£1·20
5 poles	40p	40p	70p	70p	95p	95p	95p	£1·45	£1·45
6 poles	40p	70p	70p	70p	95p	95p	95p	£1·70	£1·70
7 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£1·95	£1·95
8 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£2·20	£2·20
9 poles	70p	70p	95p	95p	£1·45	£1·45	£1·45	£2·45	£2·45
10 poles	70p	70p	95p	£1·20	£1·45	£1·45	£1·45	£2·70	£2·70
11 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£2·95	£2·95
12 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£3·20	£3·20

THYRISTOR LIGHT DIMMER



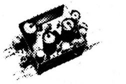
For any lamp up to 200 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price **£1·99** plus 20p post and insurance.

THIS MONTHS SNIP



1 HOUR MINUTE TIMER. Made by Smiths complete with control knob and calibrated dial. This month's special bargain at **50p.** Useful in the Kitchen, Office and Dark-room etc.

MULLARD AUDIO AMPLIFIER MODULE



Uses 4 transistors, and has an output of 750mW into 8 ohms speakers. Input suitable for crystal mic. or pick-up .9 volt battery operated. Size 2″ long × 1½″ wide × 1″ high.

SPECIAL SNIP PRICE **60p** each. 10 for **£5.**

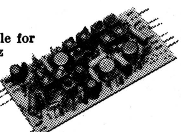
POCKET CIRCUIT TESTER

Test continuity for any low resistance circuit, house wiring, car electrics. Test polarity of diodes and rectifiers. Also ideal size for conversion to signal injector (circuit supplied), **30p** or 2 for **50p.** Post paid.

METAL LOCATOR
AUDIO TONE GENERATOR
BEE COUNTER

To receive details on these kits send s.a.e. for parts list.

MULLARD I.F. MODULE



This is a fully screened intermediate frequency module for amplification and detection of f.m. signals at 10·7MHz and a.m. signals at 470kHz. The first stage is used as an i.f. amplifier for f.m. and a self oscillating mixer for a.m. operation, in conjunction with an external oscillator coil. **75p** each. 10 for **£6·75.** 100 for **£62·50.** With connection dia.

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. **£2·25** plus 23p P. & I

BATTERY CONDITION TESTER

Made by Mallory but suitable for all batteries made by Ever Ready and others, most of which are zinc carbon types but also mercury manganese—nicad—silver oxide and alkaline batteries may be tested. The tester puts a dummy load on the battery and the meter scale indicates the condition depending upon which section the pointer rests. The section reads "replace" "weak" or "good". The tester is complete in its case, size 3¾″ x 6½″ x 2″ with leads and prods. Price **£1·75** plus 20p postage.

Thermostat with Probe. Made by the famous Ranco Thermostat Co. Covers the range from approx. 0°–20°C. variable by a control spindle, handles currents up to 16 amps. Length of capillary and sensor tube approx. 3′ 6″. These are ideal for ovens and as a general purpose thermostat. Price **50p** each or 10 for **£4·50.**

Small Tuning Condenser as fitted to many imported Japanese and Hong Kong radios. 2 gang about 200PF per gang. Size approx. 1″ × 1″ with a ⅛″ diameter spindle with dust cover. **25p** each or 10 for **£2·25.**

Heat Sink. Small type as used with OC81 etc. Price **5p** each or 10 for 45p.

Spectacle Frames. (No lenses) with built-in hearing aids. The amplifier and battery being housed in the arms. Although these are complete hearing aids we are selling them purely for the sub miniature components they contain. We give no guarantee that they are in working order also these may be secondhand. Price **£2·50** each.

Foot Switch. Twin levers each of which operates a 10 amp QMB changeover switch. Price **90p** each.

Programmers. 5 Revs per minute. Made by Magnetic Devices Ltd. The contacts may be set to trigger anywhere around the shaft, ideal for motivated lighting displays, sequential switching etc. Drive motors are 200–240v 50Hz. Model A has 5 change over contacts. Price **£1·50.** Model B has 11 change over contacts. Price **£3.**

Radiant Cooker Rings. As fitted to Tricity and many other popular cookers. We have two types. These are copper clad ⅛″ tubular construction. Both models having an external diameter of 6½″ and the elements have been slightly flattened to increase radiation.

Backer Model 7D1 MkII again 2000 watts rated but 230–240v, has no cover over element ends. Price **65p** each or 10 for **£5·85.**

Slide Switch. 2 pole change over panel mounting by two 6 BA screws. Size approx. 1″ × ⅜″ rated 250v lamp, **6p** each. 10 for **54p.** 100 for **£5·10.** 500 for **£24.**

As above but for printed circuit **5p** each, 10 for **45p,** 100 for **£4·25.**

Sub Miniature Slide Switch. DPDT 19mm (¾″ approx.) between fixing centres. **12p** each or 10 for **£1·08.**

KITS FOR PREVIOUS PROJECTS

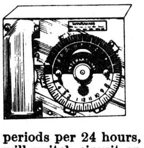
Unless otherwise stated, kits contain electronic parts only. The case and special items can be obtained locally. Also batteries are not included. Kits may be returned for refund if construction has not been started. We reserve the right to substitute components should deliveries be protracted so as to avoid undue delay.

HOME SENTINEL INTRUDER ALARM
Electronic Components with suitable case **£3·75**
SNAP INDICATOR **75p**
WINDSCREEN WIPER CONTROL
Components including metal for chassis **£2**
RECORD PLAYER. All components, but not case, loudspeaker, record deck or pick-up **£5·50**
DEMO DECK .... **£6·75** POST PAID
FUZZ BOX .... **£1·85**
PHOTOGRAPHIC COLOUR TEMPERATURE METER .... **£2·65**
ASTRON RADIO **£3**
REMOTE TEMPERATURE COMPARATOR .... **£4·25**
ELECTRO LAUGH **£2**
TRANSISTOR MICROPHONE ...... **£1·70**
AUTO ALERT
All electronic parts and metal bracket **£2·50**
RAIN WARNING ALARM
All electronic parts and chassis .... **£1·80**
WA-WA PEDAL .... **£2·90**
DARKROOM TIMER .... **£4·50**
SIGNAL INJECTOR **80p**
SOIL MOISTURE METER .... **£3·00**
SIMPLE CALCULATOR .... **£2·20**
D.C. POWER SUPPLY .... **£5·00**
BABY ALARM .... **£4·00**

Mains Transformer. Primary 240v. tapped 220v. Secondary 20v. ½ amp. Price **60p** each or 10 for **£5·40.**

Dial Thermometer—reading from 200–525F used on Tricity and other cookers. This has a flange and can be mounted through a 1⅝″ hole or alternatively it can just be rested on the object whose temperature it is required to measure. Size 2 × ⅞″ overall diameter. Depth ⅞″ below and ⅛″ above mounting panel. Price **80p** each or 10 for **£7·20p.**

24-HOUR TIME SWITCH



Made by Smiths, these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours, 5 amp changeover contacts will switch circuit on or off during these periods. **£2·50** post and ins. 23p. Additional time contacts **50p** pair.

Where postage is not stated then orders over £5 are post free. Below £5 add **20p.** Semi-conductors add **5p** post. Over £1 post free. S.A.E. with enquiries please.

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.) 7 Park Street, Croydon CRO IYD

Callers to: 102/3 Tamworth Road, CROYDON

beginner's enthusiasm.

When I read about the *Signal Injector* by Alan Jardine I was reminded of the poor beginner.

Following the instruction to solder the leads direct on to the cell will result in heating up the electrolyte and a very short life for the cell.

Perhaps this is not important as the choice of a push-on/push-off switch allows no easy means of knowing if the thing is on or off. Very few beginners will remember to test each time, and cell life will be short it is expected. A push button perhaps?

The blind cannot be expected to lead the blind, and beginners are usually short of experience.

R. Quorn
Sussex

Of your two points concerning the Signal Injector, *the first is a bit exaggerated. It is true that the cell life will be reduced by applying heat (from soldering iron) to the battery terminals but this is only negligible for the time required to execute the connection.*

To install a holder to suit this type of battery would increase the cost by about 40 per cent.

We agree that it will be difficult to tell if the unit is on or off when not in use, but it can be determined; when the unit is "on" the push button will feel "loose" but in the "off" position this looseness disappears.

If this proves unsatisfactory a push-to-make release off type can be substituted.

More Accurate Timer

May I thank you for publishing another article combining the hobbies of electronics and photography (ref. *Darkroom Timer*, March issue).

Although of excellent design, I feel it must be stated that a timer with only a 5 second timing intervals is not nearly accurate enough for the demands of the high quality black and white or well balanced colour prints that are required. However, with a small modification, I have found that the timer may be converted to an accurate piece of equipment having a timing range of 5 to 45 seconds in one second steps.

The modification requires four extra components, which are a 5 position two-pole switch (S4), VR5, VR6 and VR7 which are skeleton presets of the values, 5 kilohm, 10 kilohm and 20 kilohm respectively.

These components form an additional timing circuit which is connected in series with the original (R_t).

Position 1 of the switch has no further resistance and acts as a short circuit; position 2 connects VR5 into circuit, whilst position 3 connects VR6; position 4 connects VR5 and VR6 and position 5 connects VR7 into circuit.

Each position of the new switch is to represent a further one second delay.

Position 1 of course, has no further delay, position 2 however, will give a one second delay, position 3 two seconds etc. when the presets are set as they were in the original timing circuit.

Now, any time, in one second steps may be selected from 5 to 45 seconds by selecting the required 5 second range, plus the required extra time (if any) on the new switch.

D. G. Smith
Emsworth, Hants.

Components

Let me say first of all how much I enjoy your magazine and as a newcomer to electronics I find your *Teach-In* articles very interesting and also *Shop Talk*, etc. However, I wonder if I may make a suggestion?

I constructed your *Demo-Deck* and find that in following this series for a month or so there is a list of the more minor components used in the experiments and I wondered if it would be at all possible, either, preferably, if you could publish the list of all the components that would be required for the rest of this series in one complete list or if possible broken up into the individual months during which they will be required.

The reason I say this is, that I, like many of your other readers no doubt, have no local supplier of components in my immediate vicinity and it usually means a trip to Edinburgh or Glasgow to purchase these components.

However, if I could have a full list this would make things much easier for me. It would also make it much easier to send off a full list by post to a mail order firm rather than asking for two or three small components every month or so. I wonder if this could be done.

I am very grateful to you and wish you every success for your future publications.

R. L. Grant
Scotland

It was our intention to publish an advanced list and in future we shall be publishing, at the end of each Teach-In *every month, a list of components additional to those you have already acquired.*

Calling Gloucester

Now that I'm receiving your magazine on regular order and greatly enjoying it, I feel that I ought to go a stage further in order to get any lasting benefit from your guidance.

Can I please find out through your pages how many people in the Gloucester area are willing to ask for, and attend, an evening class on useful, basic "everyday electronics"?

Should anyone be interested, could they please write to me at the address given, then provided enough wish it, our local Education Authority can be approached with evidence that the need for such a class does exist.

Many thanks for giving me a chance to ask for these people through your very sensible magazine.

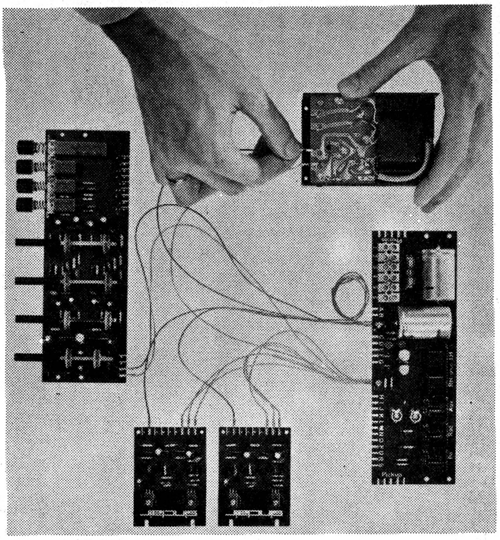
E. L. Payn
82 Innsworth Lane,
Longlevens,
Gloucester
GL2 0DE

If you write to us for advice, and wish to have a personal reply you must include a s.a.e. Unfortunately, we cannot prepare special designs, circuits or wiring diagrams, to meet individual requirements nor can we answer queries concerning commercial equipment, or subjects or designs not published by us.

For all technical and editorial matters, write to: The Editor, Everyday Electronics, Fleetway House, Farringdon Street, London, E.C.4. Phone 01-634 4452.

For all enquiries concerning advertisements or advertisers write to: The Advertisement Manager, Everyday Electronics, at the above address. Phone 01-634 4202.

Project 605 the new simple way to assemble Sinclair high fidelity modules



For several years now you have been able to assemble your own high fidelity system to world beating standards using Sinclair modules. We have progressively improved these technically but hitherto the method of assembly at your end has remained the same – there has been no alternative to a soldering iron. Now for those who prefer not to solder, there is an alternative – Project 605.

In one neat package you can now obtain the four basic Project 60 modules plus a fifth completely new one – Masterlink – which contains all the input sockets and output components you previously bought separately. Also in the Project 605 pack are all the inter-connecting leads, cut to length and fitted at each end with plugs which clip straight onto the modules, eliminating soldering completely. The pack contains everything you need to build a complete 30 watt stereo amplifier together with a clear well illustrated Instruction Book. All you have to do is to arrange your modules in the plinth or case of your choice and then clip them together – the work of a few minutes.

Your hi-fi system will, as we said, match the finest in the world and you can add to it at any time to increase power or extend the facilities. For example a superb stereo FM Tuner unit is obtainable for only £25.

Guarantee If within 3 months of purchasing Project 605 directly from us, you are dissatisfied with it, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost.

sinclair

Sinclair Radionics Ltd., London Road.,
St. Ives, Huntingdonshire PE17 4HJ.
Telephone: St. Ives (04806) 4311

Specifications

Output – 30 watts music power (10 watts per channel R.M.S. into 3 Ω).
Inputs – Mag. P.U. – 3mV correct to R.I.A.A. curve 20–25,000 Hz ± 1dB. Ceramic pick-up – 50mV. Radio – 50 to 150mV. Aux. adjustable between 3mV. and 3V.
Signal to noise ratio – Better than 70dB.
Distortion – better than 0.2% under all conditions.
Controls – Press buttons for on-off, P.U., radio and aux. Treble +15 to –15 dB at 10 kHz. Bass +15 to –15 dB at 100 Hz. Volume. Stereo Balance.
Channel matching within 1dB.
Front panel – brushed aluminium with black knobs.

Project 605 comprises Stereo 60 pre-amp/control unit, two Z-30 power amplifiers, PZ-5 power supply unit, the unique new Masterlink, leads and instructions manual complete in one pack. Post free

£29.95

To SINCLAIR RADIONICS LTD., ST. IVES, HUNTINGDONSHIRE PE17 4HJ

Please send Project 605 post free ☐ Details and list of stockists ☐

Name ....

Address ....

....

for which I enclose £29.95 cheque/money order/cash. **E.E.7B**

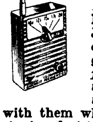
FIND BURIED TREASURE?
Transistorised Treasure Locator

This fully portable transistorised metal locator detects and tracks down buried metal objects—it signals exact location with loud audible sound (no phones used)—uses any transistor radio which fits inside—no connections needed. **FINDS GOLD, SILVER, COINS, JEWELLERY, ARCHAEOLOGICAL PIECES ETC. ETC.** *Extremely sensitive, will signal presence of certain objects buried several feet below ground* No knowledge of radio or electronics required. *Can be built with ease in one short evening by anybody from nine years of age upwards,* with the clear, easy to follow, step-by-step, fully illustrated instructions—Uses standard PP3 battery. No soldering necessary. Kit includes nuts, screws, wire, etc. **ONLY £2·85** + 25p p. & p. (Sectional handle as illustrated 95p extra). Parts available separately. Made up looks worth £15.

ONLY **£2·85**

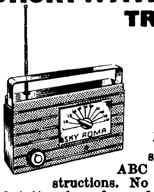
Eavesdrop on the exciting world of Aircraft Communications
V.H.F. AIRCRAFT BAND CONVERTOR

ONLY **£2·85**



Listen in to **AIR-LINES, PRIVATE PLANES, JETPLANES.** *Eavesdrop on exciting cross talk between pilots, ground approach control, airport tower, Hear for yourself the disciplined voices hiding tenseness on talk downs.* Be with them when they have to take nerve ripping decisions in emergencies—Tune into the international distress frequency. Covers the aircraft frequency band including **HEATHROW, GATWICK, LUTON, RINGWAY, PRESTWICK, ETC. ETC. CLEAR AS A BELL.** This fantastic fully transistorised instrument *can be built by anyone over nine in under two hours.* No soldering necessary. Fully illustrated simple instructions take you step-by-step. Uses standard PP3 battery. All you do is extend rod aerial, place close to any ordinary medium wave radio (even tiny portables). **NO CONNECTIONS WHATEVER NEEDED.** SEND ONLY **£2·85** + 20p p. & p. for kit including case, nuts, screws, wire, etc. etc. (parts available separately).

SHORTWAVE TRANSISTOR RADIO

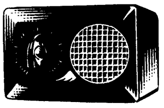


only **£2·75**

Anyone from 9 years up can follow the step-by-step, easy as ABC fully illustrated instructions. No soldering necessary. 76 stations logged on rod aerial in 30 mins.—**Russia, Africa, USA, Switzerland, etc.** Experience thrills of world wide news, sport, music, etc. Eavesdrop on unusual broadcasts. Uses PP3 battery. Size only 3" x 4½" x 1½" **Only £2·75** + 20p p. & p. Kit includes cabinet, screws, instructions, etc. (Parts available separately).

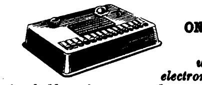
INGENIOUS ELECTRONIC SLEEP INDUCER

ONLY **£3·25**



CAN'T SLEEP AT NIGHTS? DO YOU WAKE UP IN THE NIGHT AND CAN'T GET OFF TO SLEEP. AGAIN? WOULD YOU LIKE TO BE GENTLY SOOTHED OFF TO SATISFYING SLEEP EVERY NIGHT? Then build this ingenious electronic sleep inducer. *It even stops by itself so you don't have to worry about it being on all night!* The loudspeaker produces soothing audio-frequency sounds, continuously repeated—but as time goes on the sound gradually becomes less and less—until they eventually cease altogether, *the effect it has on people is amazingly very similar to hypnosis.* A control is provided for adjusting the length of times, etc., all transistor, can be built by anyone over 12 years of age in about two hours. No knowledge of electronics or radio needed. Extremely simple, easy-to-follow, step-by-step, fully illustrated instructions included. *No soldering necessary.* Works off standard batteries, extremely economical. Size only 3" x 4½" x 1½"—take it anywhere. Kit includes case, nuts, wire, screws, etc. **SEND £3·25** + 25p p. & p. (parts available separately).

ELECTRONIC ORGAN

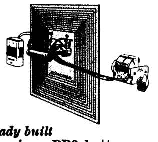


ONLY **£3·25**

Don't confuse with ordinary electronic organs that simply blow air over mouth-organ type reeds etc. Fully transistorised. **SELF CONTAINED LOUDSPEAKER.** *Fifteen separate keys span two full octaves—play the "Yellow Rose of Texas", play Silent Night", play "Auld Lang Syne" etc. etc.* You have the thrill and excitement of building it together with the pleasure of playing a real, live, portable electronic organ. **NO PREVIOUS KNOWLEDGE OF ELECTRONICS NEEDED.** No soldering necessary, Simple as ABC to make. *Anyone over nine years can build it easily in one short evening following the fully illustrated, step-by-step, simple instructions.* **ONLY £3·25** + 25p p. & p. for kit, including case, nuts, screws, simple instructions, etc. Uses standard battery (parts available separately). Have all the pleasure of making it yourself, finish with an exciting gift for someone.

Find buried treasure with this READY BUILT & TESTED TREASURE LOCATOR MODULE

ONLY **£4·95**



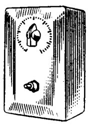
FULLY TRANSISTORISED PRINTED CIRCUIT METAL DETECTOR MODULE. *Ready built and tested*—just plug in a PP3 battery and 'phones and it's working. Put it in a case, screw a handle on and **YOU HAVE A PORTABLE TREASURE LOCATOR EASILY WORTH ABOUT £20!** Extremely sensitive—penetrates through earth, sand, rock, water, etc.—EASILY LOCATES COINS, GOLD, SILVER, JEWELLERY, HISTORICAL RELICS, BURIED PIPES, ETC. Signals exact location by "beep" pitch increasing as you near buried metallic objects. *So sensitive it will detect certain objects buried* **SEVERAL FEET BELOW GROUND!** GIVES CLEAR SIGNAL ON ONE COIN **£4·95** + 30p carr. etc. (High quality Danish Stethoscope head-phones **£2·75** extra if required.) **EXAMINE AT HOME FOR 7 DAYS. YOUR MONEY REFUNDED IN FULL IF NOT 100% DELIGHTED.**

BUILD 5 RADIO AND ELECTRONIC PROJECTS

only **£2·45**

Amazing Radio Construction set! Become a radio expert for **£2·45.** A complete Home Radio Course. No experience needed. Parts including simple instructions for each design. Illustrated step-by-step plans, all transistors, loudspeaker, personal phone, knobs, screws, etc. all you need. Presentation box **45p extra** as illus. (if required) (parts available separately) no soldering necessary. **Send £2·45** + 20p p. & p.

SOOTHE YOUR NERVES, RELAX WITH THIS AMAZING RELAXATRON



CUTS OUT NOISE POLLUTION—SOOTHES YOUR NERVES! Don't underestimate the uses of this fantastic new design—the RELAXATRON is basically a pink noise generator. Besides being able to mask out extraneous unwanted sounds, it has other very interesting properties. For instance, many people find a rainstorm mysteriously relaxing, a large part of this feeling of well-being can be directly traced to the sound of falling raindrops!—a well known type of pink noise. IF YOU WORK IN NOISY OR DISTRACTING SURROUNDINGS, IF YOU HAVE TROUBLE CONCENTRATING, IF YOU FEEL TENSED, UNABLE TO RELAX—then build this fantastic Relaxatron. Once used you will never want to be without it—TAKE IT ANYWHERE. Uses standard PP3 batteries (current used so small that battery life is almost shelf-life). **CAN BE EASILY BUILT BY ANYONE OVER 12 YEARS OF AGE** using our unique, step-by-step, fully illustrated plans. No soldering necessary. All parts including case, a pair of crystal phones. Components, nuts, screws, wire, etc. no soldering.

Only **£2·75**

£2·75+25p p. & p. *Parts available separately.*

CONCORD ELECTRONICS LTD. (EE5U) 8 Westbourne Grove, London, W.2. *Callers welcome 9 a.m.—6 p.m. inc. Saturday*

YATES ELECTRONICS
(FLITWICK) LTD.

DEPT. E.E.
ELSTOW STORAGE DEPOT,
KEMPSTON HARDWICK,
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C.W.O. PLEASE. POST AND PACKING, PLEASE ADD 10p TO ORDERS UNDER £2.
Catalogue which contains data sheets for most of the components listed will be sent free on request. 5p stamp appreciated.
10% DISCOUNT TO ALL CALLERS ON SATURDAYS

RESISTORS
½W Iskra high stability carbon film—very low noise—capless construction. ⅛W Mullard CR25 carbon film—very small body size 7·5 x 2·5mm. 4W Erie wire wound. ½W 2% Electrosil TR5.

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
½	5%	4·7Ω–2·2MΩ	E24	1·0p	0·8p
½	10%	3·3MΩ–10MΩ	E12	1·0p	0·8p
½	2%	10Ω–1M	E12	3·5p	3·0p
⅛	10%	1Ω–3·9Ω	E12	1·0p	0·8p
⅛	5%	4·7Ω–1MΩ	E12	1·0p	0·8p
4	10%	1Ω–10Ω	E12	6p	5·5p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK
0·5 watt 5% Iskra resistors 5 off each value 4·7Ω to 1MΩ.
E12 pack 325 resistors **£2·40.** E24 pack 650 resistors **£4·70.**

POTENTIOMETERS
Carbon track 5kΩ to 2MΩ, log or linear (log ½W, lin ½W).
Single, **12p.** Dual gang (stereo), **40p.** Single D.P. switch **24p.**

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Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, **5p** each. Miniature 0·25W, **6p** each.

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AC107	15p	BC108	10p	BFY52	22p	OC71	12p	1N4006	12p
AC126	12p	BC109	10p	BY127	12p	OC72	12p	1N4007	12p
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AC128	12p	BC148	13p	BZY13	20p	OC82	12p	2N29260	9p
AC131	12p	BC149	13p	OA85	7p	OC82D	12p	2N2926Y	9p
AD140	50p	BC157	14p	OA90	5p	ORP12	50p	2N2926G	10p
AF114	20p	BC158	14p	OA91	5p	1N4001	6p	2N3055	60p
AF115	20p	BC159	14p	OA202	7p	1N4002	10p	2N3702	13p
AF116	20p	BF179	32p	OC26	45p	1N4003	10p	2N3703	11p
AF117	20p	BFY50	22p	OC44	12p	1N4004	10p	2N3707	13p
BC107	10p	BFY51	22p	OC45	12p	1N4005	12p	2N3711	10p

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400mW 5% 3·3V to 30V, **15p.**

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709	50p	741	50p
710	50p	748	50p

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14 and 16 pin **16p**

BRUSHED ALUMINIUM PANELS
12in x 6in=**25p**; 12in x 2½in=**10p**; 9in x 2in=**7p.**

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160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, **3p.** 0·1μF **3½p.** 0·15μF, **4½p.** 0·22μF, **5p.** 0·33μF, **6p.** 0·47μF, **7½p.** 0·68μF, **11p.** 1·0μF, **13p.**

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250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, **3p.** 0·033μF, 0·047μF, 0·068μF **3½p.** 0·1μF, **4p.** 0·15μF, 0·22μF, **5p.** 0·33μF, **6½p.** 0·47μF, **8½p.** 0·68μF, **11p.** 1·0μF, **13p** 1·5μF, **20p.** 2·2μF, **24p.**

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0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF **2½p.** 0·04μF, 0·05μF, 0·068μF, 0·1μF, **3½p.**

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17 x 5 (plain)	—	82p
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6 way screened cable **22p**/metre

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9V mains power supply. Same size as PP9 battery.

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Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250v. Size 13½ × 11¼in. Above motor board 3¼in. below motor board 2½in.
with STEREO and MONO XTAL **£8·75** Post 25p.
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RCS 3 WATT AMPLIFIER. Ready made tested. 2-stage triode pentode valve UCL82. 3 watts output. Tone and volume controls. Rectifier valve UY85. Knobs. With high performance Loudspeaker. Response 50-12,000 cps. Sensitivity 200mV. Post 25p **£4**

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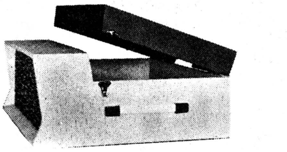

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Really smart appearance with space for R.C.S. Amplifiers and most modern autochangers. Size 18 × 15 × 8in. Metal fittings. Carrying handle. Popular colours. Two-tone rexine covered.

GARRARD SINGLE PLAY TA MK II Complete with stereo/mono plug in head. Ideal Discotheque or Hi-Fi. **£10**

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£5·75 Post 25p

Comprising a fine example of a Woofer 10¾ × 6¼in. with a massive Ceramic Magnet, 44oz, Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3¼in. square has a special light-weight paper cone and magnet flux 10,000 lines.

Impedance Standard	8 ohms
Maximum Power	12 watts
Useful Response	35 to 18,000 cps
Base Resonance	45 cps

SUITABLE ENCLOSURE 20 x 13 x 9in, £9 POST 25p

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Osc. P50/1AC	33p	Driver Trans. LFDT4	58p
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Dual cone plasticised roll surround. Large ceramic magnet. 50-16,000 cps. Bass resonance 55 cps. 8 ohm impedance. 10 watts music power. **£4·80**

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200/250v. A.C. Leaflet S.A.E. **£2·35** Post 15p

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All parts and instructions with Zener Diode, Printed Circuit, Bridge Rectifiers and Double Wound Mains Transformer input 200/240v. AC. Output voltages available 6 or 9 or 12 or 15 or 18 or 20v. DC at 100mA or less. PLEASE STATE VOLTAGE REQUIRED. Details S.A.E. Size 3½ × 1½ × 1⅝in. **£2** POST FREE

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Ideal for Mike, Tape, P.U., Guitar. Can be used with Battery 9–12v or H.T. line 200–300v D.C. operation. Size 1⅝" x 1½" x ⅜". Response 25 c.p.s. to 25 Kc/s. 26db gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **90p** Post 10p

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V	14p	250/25V	14p	50+50/350V	35p
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8/450V	14p	1000/25V	35p	32+32/250V	18p
16/450V	15p	1000/50V	47p	32+32/450V	33p
32/450V	20p	8+8/450V	18p	350+50/325V	50p
25/25V	10p	8+16/450V	20p	32+32+32/350V	43p
50/50V	10p	16+16/450V	25p	100+50+50/350V	48p
100/25V	10p	32+32/350V	25p		

LOW VOLTAGE ELECTROLYTICS
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF. 15V. 10p.
500mF. 12V. 15p; 25V. 20p; 50V. 30p.
1000mF. 12V. 17p; 25V. 35p; 50V. 47p; 100V. 70p.
2000mF. 6V. 25p; 25V. 42p; 50V. 57p.
2500mF. 50V. 62p; 3000mF. 25V. 47p; 50V. 65p.
5000mF. 6V. 25p; 12V. 42p; 25V. 75p; 35V. 85p; 50V. 95p.

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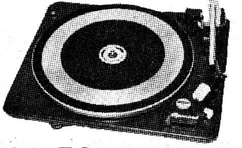

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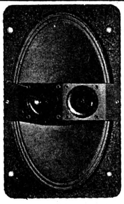

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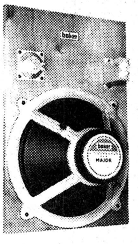

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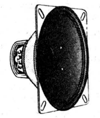

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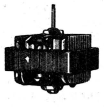

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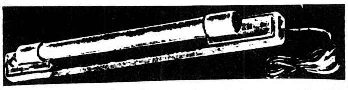

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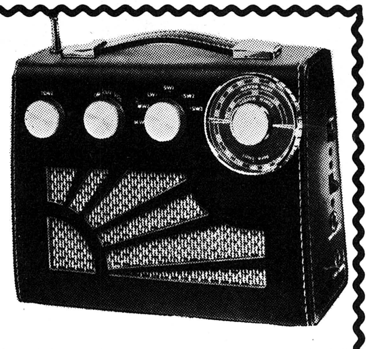

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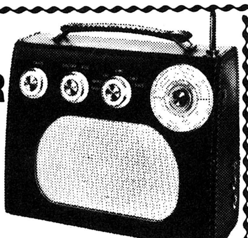

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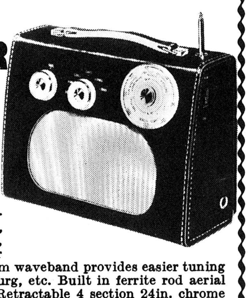

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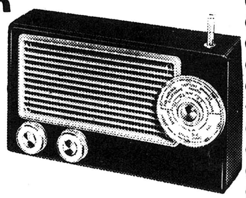

6 Tunable Wavebands: MW, LW, SW1, SW2, Trawler band plus an extra M.W. band for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2⅞in. approx. Easy build plans and parts price list 15p (FREE with parts). Earpiece with plug and switched socket for private listening **30p** extra.

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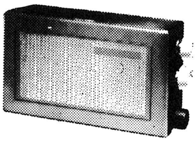

3 Tunable Wavebands: MW, LW, Trawler Band with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5½ × 1¼ × 3½in. Easy build plans and parts price list **10p** (FREE with parts). Earpiece with plug and switched socket for private listening **30p** extra.

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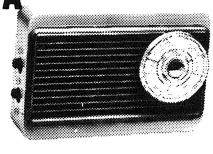

5 TRANSISTORS AND 2 DIODES

3 Tunable Wavebands: MW, LW and Trawler Band. 7 stage—5 transistors and 2 diodes, ferrite rod aerial. tuning condenser volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6½ × 4½ × 1½in. Easy build plans and parts price list **10p** (FREE with parts). Earpiece with plug and switched socket for private listening **30p** extra.

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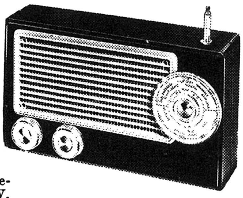

8 TRANSISTORS and 3 DIODES

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2⅞in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans **25p** (FREE with parts). Earpiece with plug and switched socket for private listening **30p** extra.

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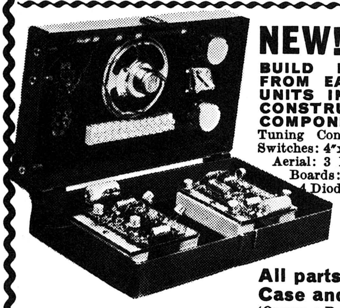

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